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COMPRESSED AIR
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SHAFT SINKING UNDER DIFFICULTIES

BY CHAS. A. HIRSCHBERG.

The undeveloped area of the Pocahontas coal field lies at considerable depth under water level, necessitating deep shafts to reach and develop these rich measures.

Extensive development, in this territory, and likewise the deepest shafts were undertaken by the Carter Coal Co., at Coalwood, W. Va., during the present year. This development and all problems and methods for overcoming the various difficulties encountered were worked out and prepared under the direction of William B. Crawford, consulting engineer for the company.

The main or hoist shaft is 16x30 ft., rectangular, timber-lined, having two hoistways and a compartment for stairway, pipes and wires. The depth when completed will be 650 ft. to the Pocahontas No. 4 seam of coal, and the development is planned for a production of 5,000 tons of coal per day. The air shaft is 15x22 ft., rectangular, timber-lined and divided into two compartments, one for air and the other equipped with a geared electric hoist for materials and men.

To hoist the required tonnage from this depth, using single-decked cages, hoisting one 4-ton car per trip, presented an unusually difficult problem. To meet these requirements and conditions, a double conical-drum hoist was designed, coupled directly to a slow-speed, direct-current motor, driven by a motor-generator set having fly-wheel equalizer and Ward-Leonard control. This hoist will be the largest and most efficient of its type, so far installed in the United States, and is now being built by the Westinghouse Electric & Manufacturing Co., at Pittsburgh, Penn.

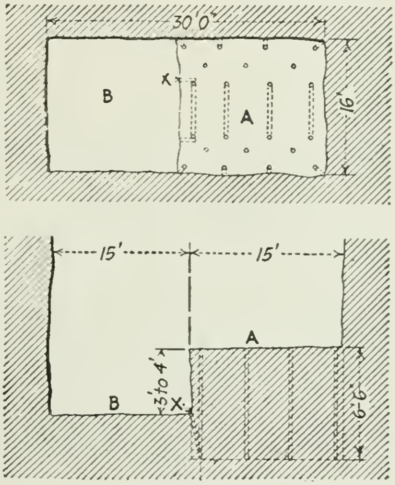


FIG. I. SHOWING ALTERNATE STEPS.

SUCCESS OF SINKING THOUGHT DOUBTFUL.

The success of shaft sinking in this territory has been considered a doubtful proposition, owing to the enormous volume of water to be passed through at various depths, and several companies have abandoned such projects, or carried them through, only at enormous cost. This company while fully realizing the magnitude of the undertaking decided after careful investigation and study that the work could be done in an economical manner, and the various streams of water excluded permanently, as well as during sinking, by forcing cement grout into the fissures and crevices of the water-bearing strata, in advance of the sinking, and thus cementing off the water over a considerable area on all sides of the shafts.

Ransome-Canniff grout mixtures are used

for this work and the grout placed under about 100-lb. air pressure. The grouting holes are drilled with a Sergeant 3¼-in. rock drill. The results obtained have been highly satisfactory, making the work of sinking reasonably dry. This company also proposes, at its second pair of shafts which are to be started in the near future, to shut off all water by grouting, before actual sinking is begun, thus making the work dry and rendering much greater speed possible when the shaft is sunk.

After the work of sinking had progressed some 200 ft., it was decided that the ordinary type of air drills mounted on shaft bars and tripods, was neither giving the best results nor making the progress desired, The space required to operate these drills interfered seriously with continuous mucking, and the delays necessary in lowering and hoisting equipment, setting columns and mounting drills were considerable, and seriously affected the average sinking speed.

After several experiments, six Jackhamer drills, of the self-rotating type, made by the Ingersoll-Rand Co., were installed and a different method of drilling and shooting was adopted. With these drills and system, each shift is required to drill, shoot and muck out, giving an average gain of 3 to 4 ft. per day in each shaft. This is considered good progress, taking into account the adverse character of the formation, and the delays on account of grouting and water, and has more than doubled the speed of the old system using the other type of drill.

The method of working and drilling is shown in the accompanying sketch, Fig. 1. The shaft is divided into two sections *A* and *B*, each being drilled and shot alternately, so that each section in turn becomes the "bench" and the other the "sump." This method of sinking permits drilling and mucking operations to be carried on simultaneously by restricting the muck to alternate sides of the shaft. This sump is kept clear of water by means of two Cameron sinking pumps.

THE ARRANGEMENT OF HOLES.

The sketch also shows the position of the various holes. The round averages 24 holes, 6½ ft. deep for each section, 8 being drilled for cut holes and 14 for squaring, while the two marked *X* are drilled last and fired with the squaring holes to act as lifters.

The average drilling time for the round, using the Jackhamers, has been reduced to from 3½ to 4 hours. The steels advance in 1-ft. changes from 2 to 8 ft., with bit sizes as follows:

No. 1—2-ft. steel, 2¼-in. six point, or rose bit.
No. 2—3-ft. steel, 2⅛-in. six point, or rose bit.
No. 3—4-ft. steel, 2-in. cross bit.
No. 4—5-ft. steel, 1⅞-in. cross bit.
No. 5—6-ft. steel, 1¾-in. cross bit.
No. 6—7-ft. steel, 1⅝-in. cross bit.
No. 7—8-ft, steel, 1½-in. cross bit.

This gives a gage variation of ⅛ in. and the steel being ⅞ in. hollow hexagonal, provides ample clearance for the cuttings to be expelled.

This is greatly aided by the hole-cleaning device, or throttle, placed on the exhaust *A*, see Fig. 2. The operator closes the throttle, forcing the air down through the hollow steel to the bottom of the drill hole, and assists the cleaning action and loosens up the cuttings by churning his machine up and down in the

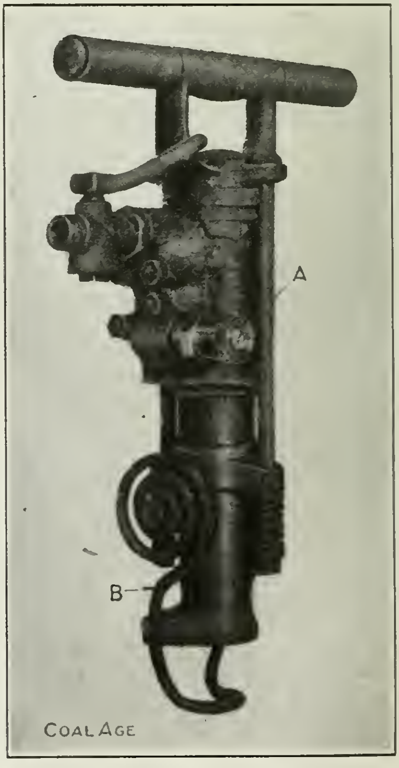


FIG. 2. JACKHAMER DRILL.

hole, the bit being held in place meanwhile by a special device. *B.*

The sinking equipment, consisting of one "Imperial" duplex and one "Sergeant AA-2" straight-line compressor, hoists, two Cameron pumps, drill sharpeners and shop tools, is all operated electrically, current being supplied by the Appalachian Power Co. from one of its numerous substations. A pressure of 100 lb. is maintained at the drills, and the explosive used is 1-in., 60 per cent. gelatin, fired with electric batteries. I am indebted to Mr. Crawford, also to J. J. Renehan, superintendent of sinking, and George E. Kerivan, for much of the foregoing information.—*Coal Age.*

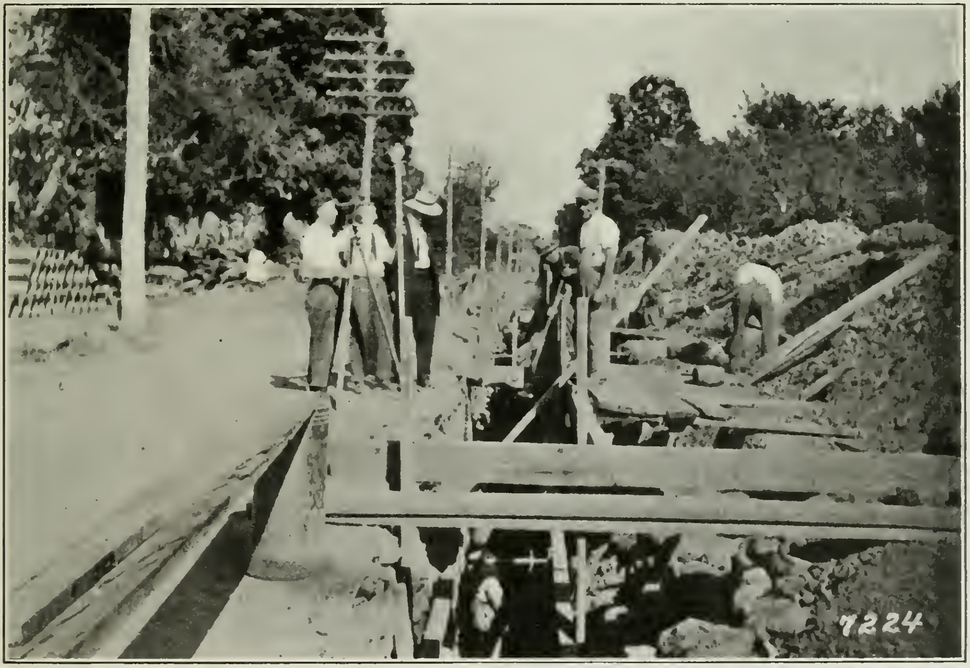


FIG. I. SINKING A DEEP TRENCH.

CUTTING A SEWER TRENCH THROUGH WITH STEAM-OPERATED HAMMER DRILL

BY CHARLES C. PHELPS.

The operating of hammer drills by steam is not very common practice, compressed air being more often used for this purpose. On certain jobs, however, steam may be decidedly more convenient; for instance, when a steam plant is already available and the size of the job does not warrant additional expenditure for an air compressing plant. In such cases there is no good reason why steam should not be employed, provided the drill is adapted to its use.

An interesting job of this sort is being carried on at New Britain, Conn. This city recently undertook to extend one of the sewers on the outskirts of the town for a distance of nearly 700 feet. The work is being done by city employes, and is in charge of Mr. John E. Moore, President of the New Britain Board of Public Works, to whom we are indebted for the data contained herein.

This sewer is for sanitary drainage and is made of 10 inch tile piping. The trench that is being excavated is 15 feet deep and about 42 inches in width. It is located at the side of the road and parallels a storm sewer that is very close to the trench, but much nearer the surface. The proximity of the storm sewer made it necessary to exercise considerable care in cutting, shoring and blasting, so as not to disturb the older sewer. Figure 1 gives a good general idea of the trench and its surroundings. The old storm sewer is directly under the pile of excavated earth. The cut is principally in earth for the first five feet and

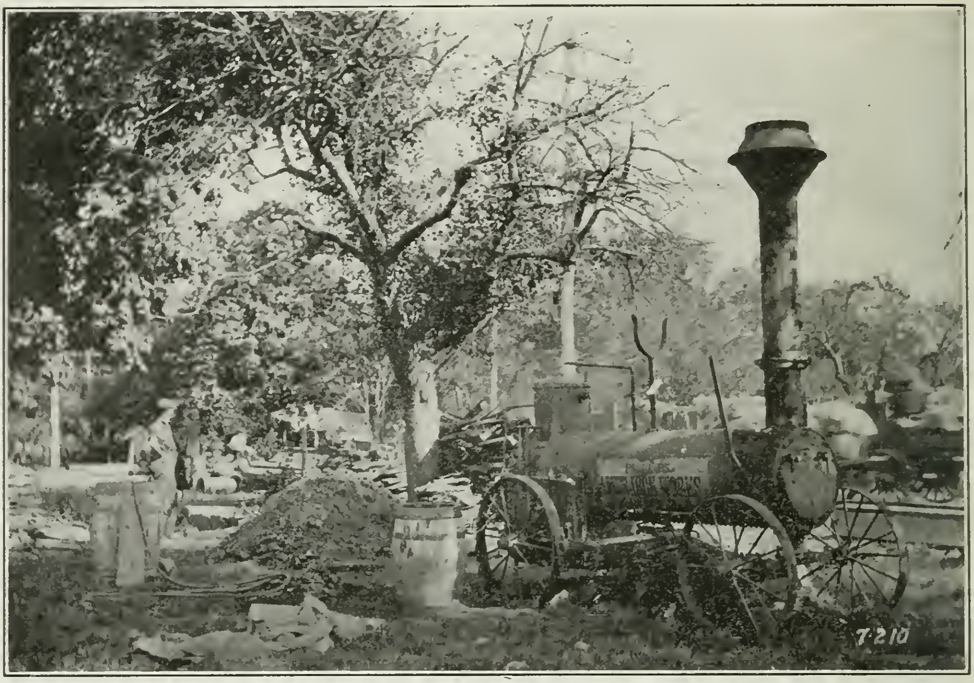


FIG. 3. THE POWER PLANT.

in trap rock for the lower ten feet. The rock varies greatly in hardness, increasing the difficulty of drilling. Some of the rock encountered is extremely hard, and some is soft, oxidized trap.

About 525 feet of trench had been cut on the date when the accompanying photographs were taken, August 11th, 1913, leaving about 160 feet of trench still to be excavated.

Two Jackhamers are employed, their two operators accomplishing a much greater amount of work than the six drillers who had formerly carried on this work by hand methods. The drills are operated by steam at a pressure of nearly 80 pounds per square inch. Practically the only difference between these drills and Jackhamers for air operation is in the piston, which is very slightly smaller in diameter in the steam drill to allow for expansion when the machine heats up. The drill handle being of wood, remains cool. A short pipe screwed into the drill outlet conducts the exhaust steam away from the operator, so that it is a very comfortable job to operate one of these drills even in warm weather. One particularly important feature of the Jackhamer is the automatic rotating device, by means of which the steel is rotated in the drill chuck thus making it unnecessary to oscillate the drill by hand. The great advantage of this feature for trench work, where quarters are often cramped, will be at once apparent. When operated by air, a hollow steel is used with the Jackhamer. By means of a hole-cleaning device attached to the Jackhamer, the air can be sent down into the hole at the will of the operator, effectively cleaning it of cuttings. A steel retainer also adds to the ease of manipulating the machine, as the steel and drill can be churned up and down in the hole while blowing out the cuttings, thus hastening the operation. With steam operation, however, the hole-cleaning arrangement did not prove to be very satisfactory in this rock, so the hole is kept full of water poured in from a pail. The cuttings are scooped by means of a tree branch having a smashed end. The branch is driven into the hole and withdrawn quickly, this pump-like action forcing the water and cuttings out of the hole in a satisfactory manner.

The sides of the five foot earth cut are shored up with planking. The first cut made in the rock is about 4 feet deep to get below the level of the adjoining sewer. The remaining six feet is bored in two cuts of 3 feet each. The spacing of the holes averages about 2½ feet both lengthwise and crosswise.

Three changes of steel are used per cut. The starting bit is 2 in. diameter, the second is 1¾ in. and the bottoming bit is 1½ in. After drilling a hole to bottom, a wooden plug is inserted in it to keep out dirt, etc.

A six-point bit is employed for drilling the softer rock, but in the harder rock a cross bit is used.

Four sticks of 60 per cent. dynamite are used per hole. At the beginning of the work 40 per cent. dynamite was used, but it proved not to have sufficient strength for this kind of rock.

The number of laborers on this work has varied at different stages of the work. The foreman has general charge and looks after the boiler as well. There are two drill runners. The force of muckers who remove the spoil with pick and shovel and replace it, has consisted at various times of from 15 to 40 men. At the time the pictures were taken there were 26 on the job.

There is one nine-hour shift per day, excepting on Saturdays, when the shift is of 5 hours' duration. The rates of wages are as follows:

Drill runners........	$2.50 per day
Laborers	2.00 per day
Blacksmith	2.25 per day

The speed of drilling has varied greatly owing to the varying hardness of the rock. Sometimes the performance of the two drills has run as high as 80 feet per 9-hour shift, and sometimes it has run as low as 50 feet, but the average drilling performance has been 60 feet of hole per day, or more, which is equivalent to about 7 feet of hole per hour in trap rock of average hardness. The very poorest record for a single day's work with one drill has been 10 feet of hole. Taking the average figure of 30 feet per day per drill, the labor cost of drilling would be 8⅓ cents per foot of hole.

The blacksmith and his helper devote about seven hours of the nine sharpening the steels. For both drills not more than 8 inches of steel broke off and caused trouble during three months of work.

The power plant for this job consists of a portable Ames steam boiler carrying about 80 lbs. pressure. The water is fed to it by an injector, the water consumption averaging about 192 gallons per day. During the first eleven weeks of constant operation about 4½ tons of soft coal were consumed.

Leading from the boiler is a one-inch iron pipe which crosses the road and connects with several lengths of pipe of the same diameter, laid along the ground beside the trench. This pipe has tees at convenient distances for connecting the drill feeds. When it becomes necessary, with the advance of the work, to move the boiler along, the back lengths of pipe are unscrewed and connected to the front. The drill feeds are ¾ inch rubber steam hose.

Figure 2 shows one of the drill runners at work on the bottom cut of the trench.

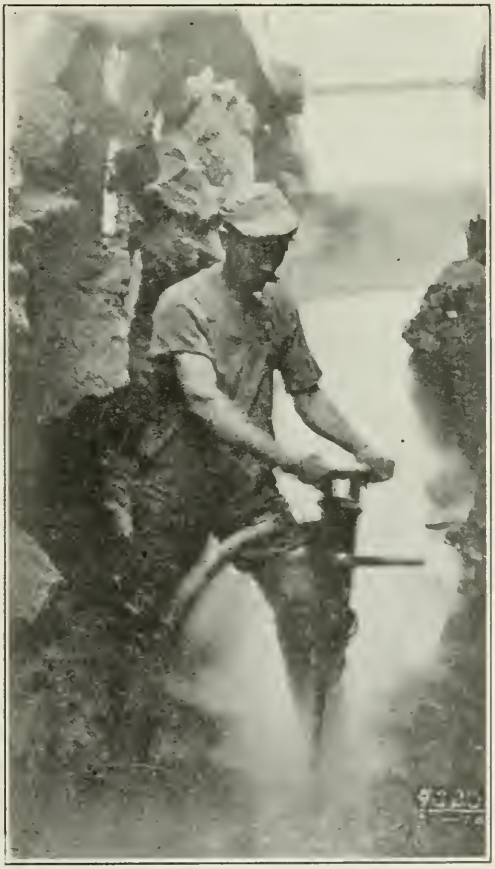
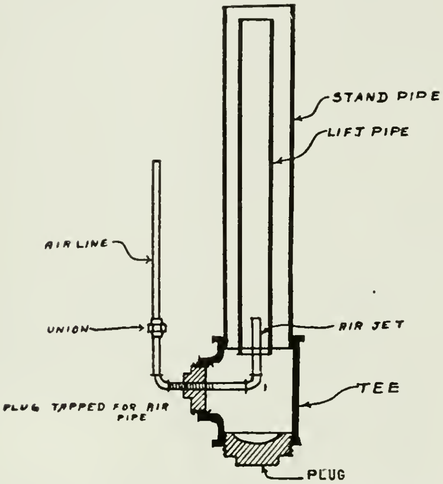


FIG. 2.

AIR LIFT FOR ELEVATING PULP IN CYANIDE PLANTS

BY R. H. SHAW.

The following sketch is a suggestion for the construction of airlifts for ues in elevating pulp in cyanide plants. This design has been used at the Colburn-Ajax mill for some time past, and has proved very satisfactory in every way.



In raising pulp by means of airlifts, one encounters the problems of broken compressors, chips of wood, pieces of belt, and numerous other things, which, with almost human maliciousness, find their way into the pipes. These cause chokes which are difficult to loosen and may cause serious delay. The design given is made with the object of accessibility and rapidity in removing chokes.

In case of a choke, the plug on the bottom of the tee is removed. This drains the standpipe and lift-pipe, and usually cleans out everything except the air line. Next the union on the air line is disconnected and the other plug, together with the horizontal nipple, is removed from the tee. The horizontal nipple is screwed into the elbow (marked 1) loosely, so that it readily comes apart at that point while the plug is being unscrewed. All the pipes now can readily be cleaned of sand or slime.

To replace the parts the vertical nipple and elbow (marked 1) must be held in place through the bottom of the tee and the air pipe screwed in at the same time as the plug in the side of the tee is replaced. The bottom plug is then put back into place and the lift is again ready to operate. The maximum time usually required for this complete operation is about 10 minutes. The loss of pulps and solution is negligible compared to the time saved.

This construction requires the lift to be at least one foot above the floor and supported from clamps around the pipe. Ordinarily, both of these details are readily accomplished.

LAPLAND IRON MINES

One of the most important iron mines in the world is the Loussavaara-Kürunavaara, situated at Kiruna, Lapland, in latitude 68½ degrees north, which is about the same as the northernmost boundary of Alaska. The climate is somewhat milder than in Alaska, and these mines are worked the year around. About 1,600 men are employed and the equipment is all of the most modern machinery obtainable. Machine tools for the repair shop, air-compressors, and rock-drills, and several of the largest steam and electric shovels are of American make. The plant is operated by steam power, the coal coming from England and Spitzbergen. The electrification of the mines is in progress, and this power will be used exclusively as soon as the new power-plant of the state of Sweden, now under construction at Porjus falls, is completed. The capacity of this station will be 150,000 hp. to be transmitted at 78,000 volts over a distance of 150 miles. The ore is shipped from Kiruna to Narvik on the Norwegian coast by rail, and from there by water to Germany, a small percentage finding its way to other countries. The equipment is being rapidly increased and will soon be sufficient to ship more than 10,000,000 tons per annum. Up to the present time about 25,000,000 tons of ore has been shipped. The ore is magnetite and contains from 53 to 68½ per cent. iron. Owing to the comparatively large content of phosphorus it was impossible to utilize it until the Thomas furnace was developed.—*Daily Counsular Report.*

According to the English coal mines act a place shall not be deemed in a fit state for working if the air contains less than 19 per cent. oxygen or more than one and one-quarter per cent. carbon dioxide. The percentage of inflammable gas must not exceed 0.25 per cent. in an intake air-way.

ARRANGEMENT AND CONSTRUCTION OF FACTORIES*

BY W. L. SAUNDERS.

Having selected a site, the next question of greatest importance is the laying out and construction of the buildings. Each line of product calls for such an arrangement as would best facilitate the handling of it. In textile work, for instance, buildings arranged in blocks, many stories high, are economically correct, while in the heavy machinery line a ground floor shop is best.

SAW-TOOTH ROOF CONSTRUCTION.

The saw-tooth construction still holds supremacy for works built all on one floor. This saw-tooth construction comprises a series of gables arranged like the teeth of a saw, the glass in the gable facing the north, and thus giving plenty of light without sun. This construction is in the main a series of steel or iron posts spanned by trusses and so arranged that extension in any direction is easily effected. The cost of a saw-tooth building is low when compared with any other type of building. Complete with cement flooring and roof it is about one dollar per square foot.

The saw-tooth building has the disadvantage of not affording means for transportation of material by overhead cranes, so that it is used mainly where the product is light enough to be transferred by trucks.

MULTIPLE STORY CONCRETE.

The multiple story concrete building is a modern design, which in some cases replaces the saw-tooth construction. This multiple story building is practically cast over steel frames. The entire surface area of each floor above a point some four or five feet from the floor line is glass, and all the rest of it, including floors and ceilings, is concrete or brick. This building is a monument, indestructible by fire, with plenty of light, and its cost per square foot of floor area is less even than that of the saw-tooth construction. Such a building is suitable for light manufacture where the product comprises certain things which are made wholly or in part on each floor. Freight elevators are provided for transporting the material from one floor to the other. This construction, of course, occupies less space than the saw-tooth type, and the only prominent disadvantage is that if it becomes desirable to increase the space for turning out the product of one floor only, other than the ground floor, it will be necessary to extend all of the floors simultaneously.

FIRE PROTECTION.

Whatever the type of building adopted most earnest consideration should be given to the question of fire protection. The day of wooden shops is over, because of the burden of insurance and the danger arising from a possible paralysis in business. Fire rates are nowadays brought down to a negligible figure by proeprly designing the works. It was originally supposed that buildings should be detached one from the other so as to prevent the possibility of total loss, but with the modern steel and concrete structure this is not necessary. Even the sprinkler system, which became general in works a few years ago, is becoming obsolete and unnecessary in buildings of reinforced concrete which are practically indestructible.

In pattern shops and in places where there is inflammable material in storage or in process of manufacture, even though the building be absolutely fire proof, it is best to provide sprinklers, because should a fire occur, the sprinklers confine the flames to a limited section, and thus save property and perhaps life, but in general machinery manufacture sprinklers are unnecessary, where the buildings are properly constructed.

TYPE OF ORGANIZATION.

Organization is of paramount importance in all manufacturing. Success or failure depends upon organization, and first in importance is the manager. Only a day or two ago I received through the mail a little circular from a Corps of Efficiency Engineers, which attracted me because of the head-line, "The Needs of the Successful Manager." This circular goes on to state that "the chief necessity of the successful factory manager is knowledge." It then enumerates eleven points of importance, which, according to this circular, qualify the successful manager.

The first point is—that he must know that his Purchasing Department is being operated on an efficient basis. It then goes on to specify that his knowledge must extend to the question of waste in each department, he must know the cost elements, the productive capacity of the works, the assets and liabilities of the company, and finally "he must know that his Sales Department is being handled in the best possible way."

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*Abstract from address before the Graduate School of Business Administration, Harvard University, Sept. 26, 1913.

From the standpoint of Efficiency Engineers seeking business this may be all well and good; but these specifications do not correctly characterize the successful manager. The first and the governing consideration is the handling of men. This is the hall mark of the successful manager; all else is secondary in importance. The manager who knows how to handle men knows how to organize the works for the best results. He is the court of last resort, he must be the one to say "Yes" or "No" in the works, and without such a man success in manufacturing is always jeopardized.

The successful manager provides a superintendent under him who handles the foreman of each department, or in some large works the manager provides a superintendent for each department, each superintendent reporting to him and the foreman reporting to the superintendents. The extent or size of the works governs details of this kind, but the qualities that make for success in a manager are executive ability and a capacity to inspire confidence in his organization. He must be in touch with his official family, that official family meaning all the superintendents, heads of departments and clerks, even in some cases going down to the office boys. He need not be in touch with the man at the lathe, the mechanic or the workman, but he should know his boss.

Regular meetings for assimilation of ideas betweeen the manager and his official family will mean the efficiency and success of the organization. I have known of cases where two or three superintendents of different departments, all of them good men, yet jealous of each other, disliking each other, not associating with each other at home, were brought to a condition of friendship and cooperation by meeting daily at lunch with the manager and sitting at the same table with him.

I cannot agree that the successful manager must know that his Sales Department is being handled properly. The less he has to do with this the better. In fact I have never seen any advantage derived from having the Sales Department or the Executive Force of a company located directly at the works. The manager's business is to turn out the product expeditiously and efficiently. If his time is occupied in daily reporting to the President or other officials of the organization, discussing questions with them, he cannot be directing the works. His best work is done where he is isolated, reporting personally weekly or monthly to the Sales Organization, but being all the time on his job and knowing that he has the confidence of the officials and of the men.

Human nature is a governing force among working men. If they are treated well and have confidence in their boss they will do their best work. The inspiration of confidence must come from the manager, his character is stamped upon the entire organiaztion.

ATMOSPHERIC INDUSTRIES IN NORWAY

An English company, the Northwestern Cynamide Company, has built large works at Odda, on the Hardanger Fjord, and established, on a successful basis, the manufacture from atmospheric nitrogen of calcium cyanamide, which is competing with Norwegian calcium nitrate for recognition as the most economic form in which the air can furnish nitrogenous compounds for the needs of agriculture. The firm shipped 752 metric tons in 1909 and 4,281 tons in 1910. The price is $42.88 per metric ton. The industry is evidently on a firm footing and finds a market for its products, as do similar works in Germany.

At Notodden, in 1905, the first factory for manufacturing nitric acid directly from the elementary gases of the atmosphere was erected. In an enlarged form it now gives occupation to 500 workmen and is daily demonstrating the remarkable possibilities of this new factor in chemical industry, and in economic evolution. The factory furnishes constantly increasing quantities to foreign countries. The exports for two years were as follows: 1909—calcium nitrate, 9,422 tons; sodium nitrate, 3,200 tons; sodium nitrate, 1,074 tons.

THE WEBER SUBURBAN PUMP

The Weber suburban pump here illustrated is designed especially for suburban service. It is operated by compressed air and can therefore be located at any distance from the operating machinery. The power plant consists of an air compressor, an electric motor, or gasoline engine, and an air receiver. A special pump house near the well or spring is not required. The compressor and motor can be placed in the basement of the main house, in the garage or in any other outbuilding to protect them from the weather. One air pipe and one water delivery pipe, both placed below the frost line, connect the pump with the power and service ends. The operation may be entirely automatic, outside of an occasional oiling and cleaning. The water remains in the ground, its natural reservoir, until needed for use.

This pump differs, therefore, from the so-called water storage or pressure tank system in two main points: (a) *Convenience in attendance;* it is not necessary to leave the house to start the pump; (b) *Quality and freshness* of the drinking supply; by opening a faucet pure water at ground temperature and *uniform* pressure is available.

OPERATING DETAILS.

The pump is of the direct displacement type. Water enters the inlet valve at the bottom of the pump chamber when the chamber is submerged. Air pressure is applied directly to the upper surface of the water and forces it through the discharge pipe direct to the plumbing service, so that a constant supply of cool and fresh water is available at every faucet. Admission of air from the air receiver is controlled by means of a combined regulating and reducing valve, also a reversing valve, as shown in the piping diagram, Fig. 3. The reducing valve is under control of the house water pressure and shuts off the air supply to the reversing valve and pump chamber when the house service line is fully charged. The withdrawal of a cup of water is sufficient to admit a supply of air to the pump chamber to replace the water withdrawn, as the reducing valve is sensitive enough to open wide with only ¼ pound change in pressure.

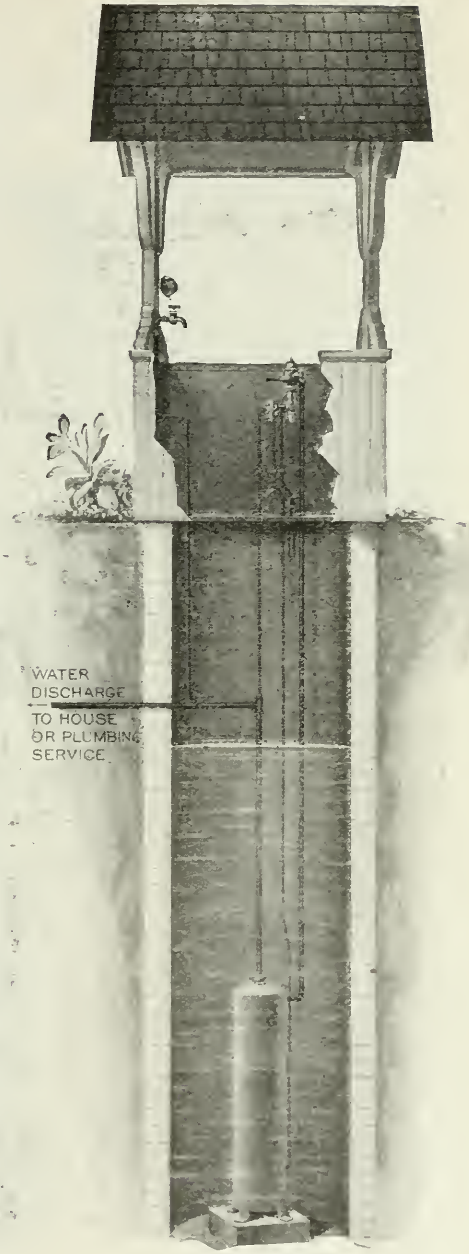
WATER DISCHARGE
TO HOUSE OR PLUMBING SERVICE

FIG. 1. WEBER SUBURBAN PUMP.

For Open or Dug Wells, Lake, Cistern, or Springs.

The pump will deliver water as long as the air receiver gauge indicates a pound above the required working pressure. With an automatic starting device the compressor is then started and when the air storage tank is

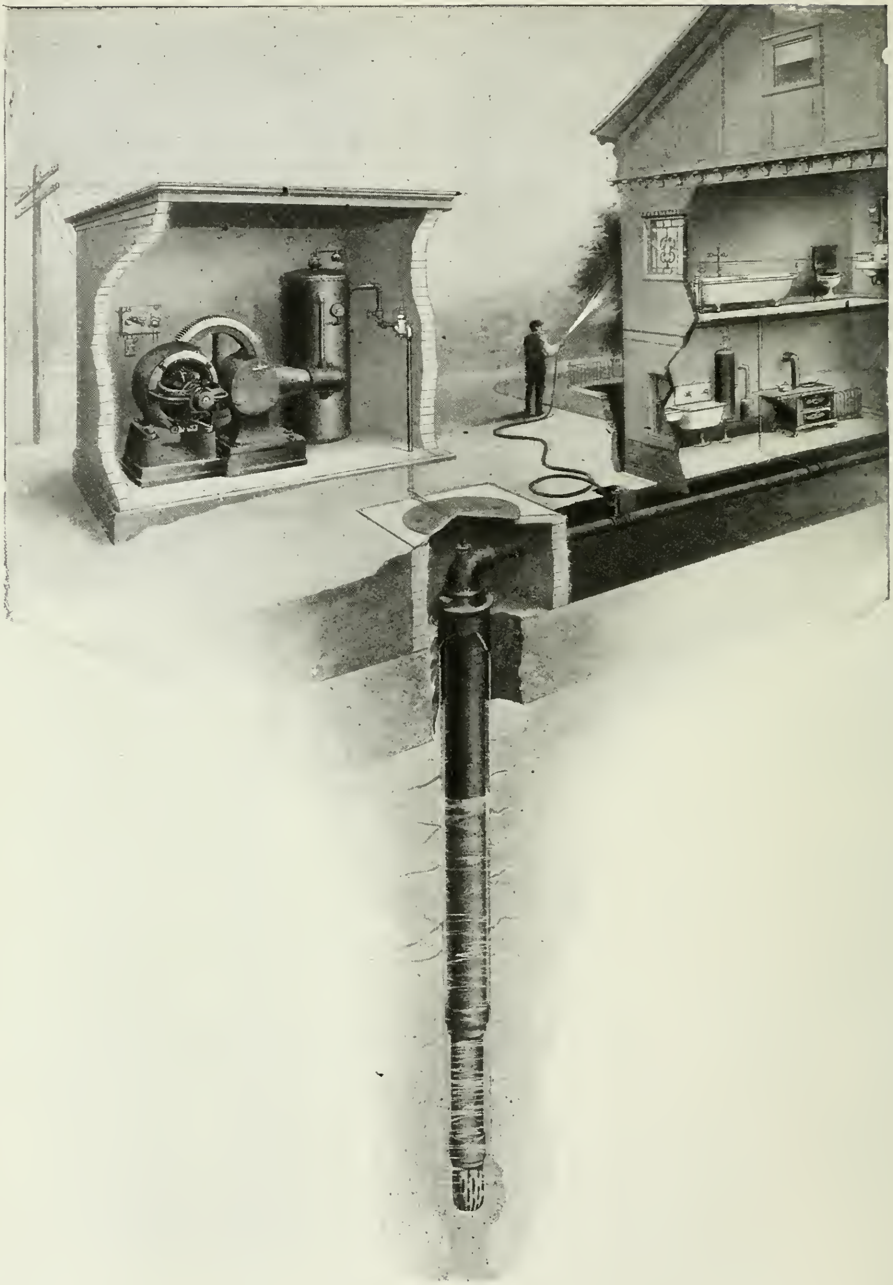

FIG. 2.

charged to about 100 lbs. pressure the current is automatically cut off and the compressor remains idle until the air supply has been used.

When the power plant is equipped with an electric stopping and starting device, the air receiver may be of smaller size than with a gasoline engine power plant, for the electric

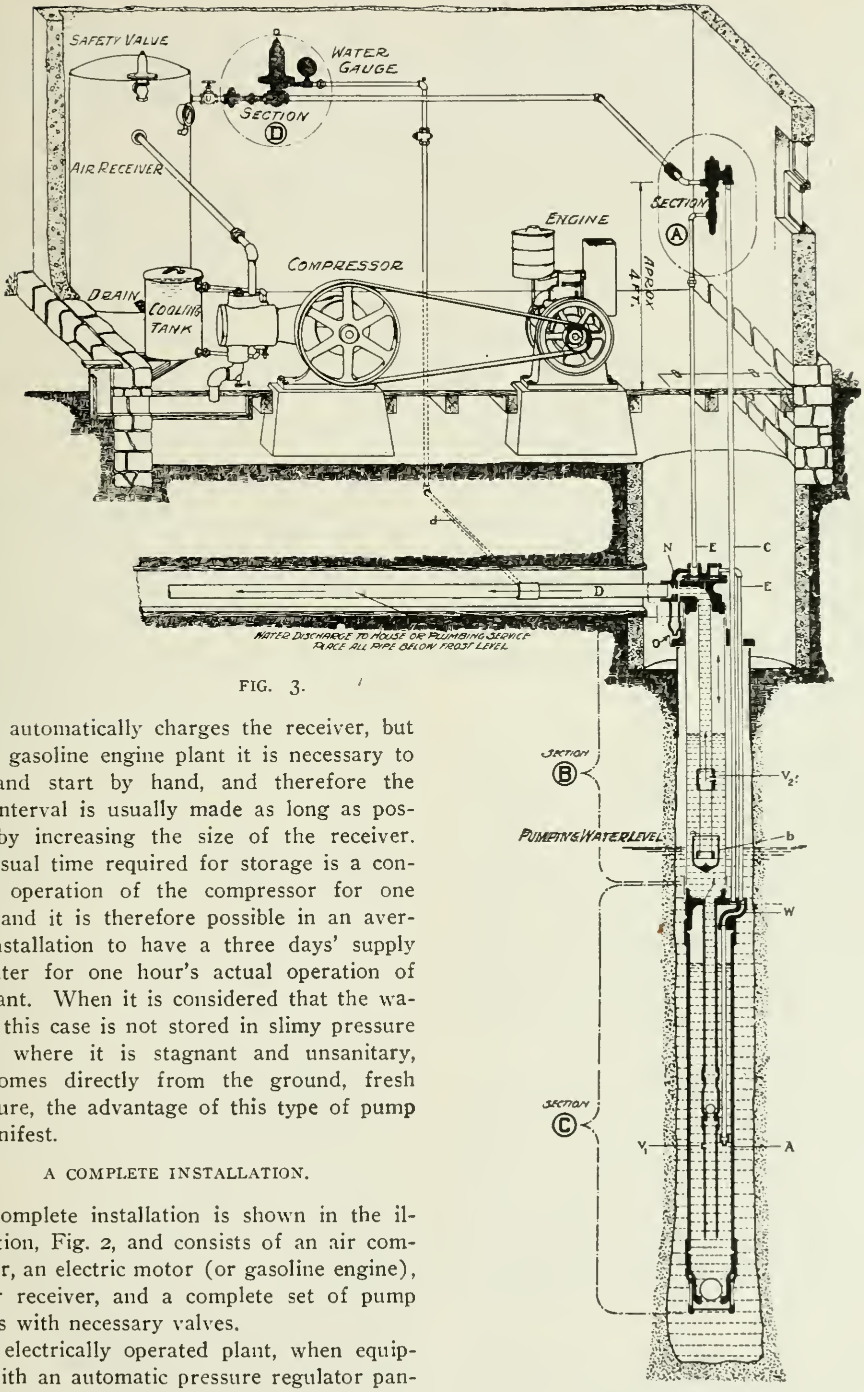

FIG. 3.

device automatically charges the receiver, but in the gasoline engine plant it is necessary to stop and start by hand, and therefore the time interval is usually made as long as possible by increasing the size of the receiver. The usual time required for storage is a continual operation of the compressor for one hour, and it is therefore possible in an average installation to have a three days' supply of water for one hour's actual operation of the plant. When it is considered that the water in this case is not stored in slimy pressure tanks, where it is stagnant and unsanitary, but comes directly from the ground, fresh and pure, the advantage of this type of pump is manifest.

A COMPLETE INSTALLATION.

A complete installation is shown in the illustration, Fig. 2, and consists of an air compressor, an electric motor (or gasoline engine), an air receiver, and a complete set of pump fittings with necessary valves.

An electrically operated plant, when equipped with an automatic pressure regulator panel, under control of the air receiver pressure, possesses advantages over other types of installations on account of the automatic feature of stopping and starting. The only attention required is an occasional oiling. The air compressor may also be driven by steam or from a counter-shaft. The air receiver is usually charged to pressures up to 100 or 125 pounds per square inch, and may be of the horizontal or vertical pattern. It may be placed according to convenience, in the power house or outside.

The pump is made in four stock sizes, ranging from 120 gallons per hour to 1,500 gallons per hour. The open well type is made of galvanized iron and fitted with water valves of standard pump design. The deep well type is made for wells from 4" in diameter upward, and the design permits of pumping from any depth or pumping water level. The deep well type is constructed of common pipe and special bronze fittings, shown in sectional diagram, Fig. 3. Fig. 1 shows the arrangement for open or dug wells, lake, river, etc., the range of lifts and pressures being the same as in other cases.

VENTILATING AND COOLING IN TUNNEL DRIVING*

A great gap has been filled in the field of ventilation since the driving of the Mont Cenis tunnel, where the only air available was obtained from the exhaust of the rock drills. The miners' anemia was high and the driving progress was very slow. As a matter of fact, it would have been impossible to consume much explosive or to have many shifts working in the tunnel at the same time.

The same conditions prevailed when driving the St. Gothard tunnel, where only 70 sec. ft. of air was made available for ventilating purposes. The miners' anemia was intense; on the south side of the tunnel as many as 60 per cent. of the men were more or less affected. During bad periods men would quit work after two months, although working only two out of three days, with five working hours only per day.

The poor ventilation, combined with the relatively high rock temperature, and the rudimentary sanitary conditions were a great hindrance to progress, and it is stated, for instance, that the contractors lost as many as 20 horses per month.

The sanitary conditions at the Arlberg tunnel, together with the introduction of a ventilating system capable of delivering from 100 to 200 cu. ft. of air per second, were a great help toward good progress. It is true that the overlying mass was small, thus causing the maximum rock temperature not to exceed 65 deg. Fahr., but the use of Brand water drills made it impossible to use the exhaust for ventilation.

COOLING THE AIR.

When in 1891 the Simplon project was taken up the maximum rock temperature expected to be encountered was 108 deg. Fahr. A very substantial system of ventilation was recommended by the commission of engineers charged to report on the feasibility of this project, and after the impracticability of using ventilating pipes for such an undertaking had been demonstrated theoretically, twin tunnels were recommended. The consistency of the results of this computation with practice was only too well proved when, during the driving period of this tunnel, the rock temperature rose to 132 deg. Fahr. and necessitated an elaborate refrigerating system in addition to the ventilating plant of some 1200 sec. ft. capacity.

One cannot realize the meaning of an accidental shut down of the ventilating plant in an undertaking of this kind. Imagine hundreds of men working some 30,000 ft. away from the portal, in an atmosphere saturated with humidity, vitiated by gases due to the consumption of hundreds of pounds of explosives, and in a temperature of 130 deg. Fhr.

The limit of efficiency of cooling the air in a deep tunnel by introducing air from outside is rapidly reached, especially during the summer months. In the Simplon tunnel this limit was reached when the rock temperature was about 100 deg. Fahr. It was then found necessary to use auxiliary methods, either to avoid heating the air used for ventilation or to cool it after heating. It is preferable to keep the air for ventilation at as low a temperature as possible, either by insulating the air-conveying

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*Portion of an article by E. Lauchli, Civil and Hydraulic Engineer, New York, in *Engineering Record,* Nov. 8, 1913.

Name of tunnel	Simplon	St. Gothard	Loetschberg	Mt. Cenis	Arlberg	Ricken
Tunnel length, ft	65,042	49,147	47,680	42,145	33,600	28,200
Maximum elevation of range penetrated, ft	9,320	9,380	9,650	9,675	6,660	3,620
Maximum overlying depth, ft	7,000	5,570	5,550	5,430	2,360	1,740
Maximum rock temperature, deg. Fahr	130	88	94	85	65	74
Approximate number of men in tunnel	800	400	600	250	700	140
Explosives used per 24 hr., lb	1,100	660	900	440	770	500
Ventilating air, per sec. ft	1,270	70	300-350	18-35	100-200	110-140

VENTILATION STATISTICS FOR SIX LONG AND DEEP TUNNELS.

pipes, if any, or by insulating the walls of the heading or tunnel with a thin coat of cold water by means of pulverizators or jets. Both systems are costly, especially the second one, unless cold water is available under natural pressure.

The problem of ventilating deep tunnels during and after construction has become a complicated one, requiring in itself the constant attention of an engineering staff and laboring force especially assigned to this work. The following figures published by Dr. Pommetti for the Simplon tunnel, north side, give only a small idea of the advantages gained by an efficient ventilating and refrigerating system: Out of a total of 3,445,754 man-shifts only 52,677, or 1.53 per cent., represented sickness. There were 37 deaths caused by illness and 30 by accident.

The table gives the amount of air provided for ventilation during the driving of six long and deeply overlaid tunnels.

RECORDS FROM THE UPPER ATMOSPHERE*

On December 17, 1912, a balloon, liberated by Professor Gamba, from the aerological observatory at Pavia, Italy, reached an altitude of 37,700 metres (123,600 ft.; 23.4 miles). The balloon used was made of para-gum, was inflated with hydrogen, and was provided with a parachute. Its diameter, 1.9 m. (74.8 in.) was made necessary by the special apparatus to be carried. The flight was entirely normal, and the balloon returned to the earth at a distance of only 24¼ miles.

The minimum atmospheric pressure recorded was 2 mm. (.078 in. of mercury, .038 lb. per sq. in.), this of course at the greatest altitude. The minimum temperature registered was 56.9 degrees C. at the height of 19.730 m. (64,800 ft.). The stratosphere was encountered at 12.385 m. (40,600 ft.), with a temperature of 55.5 degrees C.; the temperature in it remained constant for some time, then increased and later diminished, again increased and reached finally 51.6 degrees C. at the maximum altitude registered.

What really are the explanations of the unusual phenomena observed at the higher altitudes, the layers of heat inversions, their variations according to the seasons and their influence upon general meteorology?

As a matter of fact, to the gases contained in the atmosphere are due the different observed phenomena; for example, combustion, breathing, etc. Upon the surface and at points very close to the surface of the earth, the constituents of the atmospheric air are known with great precision; the gas which we breathe consists of a mixture of 78 volumes of nitrogen and 21 of oxygen; the 100th part remaining contains carbonic acid, aqueous vapors, small proportions of argon, and other rare gases such as helium, neon, etc. It should be noted that the aqueous vapors and carbonic acid occur in different proportions in different specimens of air that have been analyzed. The average weight of the atmosphere at sea-level corresponds to the weight of a column of mercury 760 mm. high (29.9 in.).

When we leave the lower altitudes, either by climbing a high mountain, or by balloon, we observe that the density of the air decreases, that combustion is made with more difficulty, that breathing becomes more laborious; all these phenomena indicate to us that the thickness of the gaseous envelope is not without its limits. Actually, this layer is carried around with the earth in its rotation upon its axis, and from this it follows that in the higher regions the gaseous molecules will be greatly decreased for the reason that two forces act upon them—gravity, which tends to bring them together at the centre of the earth, and the centrifugal force, which, affecting them inversely, tends to drive them away from the earth.

Through some limiting surface, one of these forces becomes predominant; if the centrifugal force is in excess, the particles are no longer retained by the earth, are driven away

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*Abstract from *La Nature.*

from its influence, and consequently cease to be a part of our atmosphere. Calculation shows that this surface lies about 5 or 6 radii of the earth distant from its surface. This corresponds approximately to one-tenth of the distance from the earth to the moon. Its theoretical limit is 34,000 km. (21,200 miles).

Shooting stars make possible exact measurements of the thickness of our atmosphere. Aerolites entering it with great velocity meet the gaseous atmospheric particles, become heated by friction up to luminosity, and therefore become visible to an observer situated upon the surface of the earth. Simultaneous observations made at different localities enable us to calculate by triangulation the height at which this atmosphere was met by the aerolite. The greatest altitudes obtained by this process are in the neighborhood of 200 to 300 km. (125 to 187 miles).

From the physical viewpoint, the lower part of the atmosphere may be considered as comprising three layers.

The first reaches from the earth's surface up to approximately 3,000 m. (10,000 ft.). In this zone there exists almost the entire quantity of water vapor and dust; here the phenomena depend upon the inequalities of the earth's surface, because these cause and here originate nearly all of the greater atmospheric disturbances. The temperature here decreases very irregularly, and often shows the phenomena of inversion; that is to say, that instead of decreasing as the altitude increases, it becomes warmer in certain layers, the thickness of which can reach 1,500 to 2,000 m. (1 to 1¼ mile). This atmospheric layer has been very thoroughly studied by means of observers in balloons, by captive balloons, and principally by kites.

The second layer lies from 3,000 up to 10,000 m. (6 miles). In it are found only a few clouds, and the temperature uniformly diminishes. At 10,000 m. are observed the lowest temperatures, with some very attenuated clouds, which consist of ice particles; also at about this altitude man is obliged to halt. On July 31, 1901, Berson reached a height of 10,800 m. (35,500 feet).

By kites and by observers in balloons we have been able to explore the lower levels of the second layer to between 5,000 and 6,000 m. Contained in these two first layers is that which Leon Teisserene de Bort has called the troposphere, because of his theory that in this region occur the vertical movements of the air.

The remainder of the atmosphere belongs to the third zone, which is known as the stratosphere, for the reason that in it the vertical movements of the air do not exist. To explore this layer thoroughly it is necessary to use the free balloons; that is to say, small balloons made of paper or caoutchouc, liberated at the earth's surface and to be recovered later if possible.

The caoutchouc balloons are similar to those given to children, but of better quality and larger, their normal diameter varying from 0.4 up to 2 m.

During flight the diameter can reach 6 to 8 m. before the caoutchouc will disrupt. The size most ordinarily used is 6 m. in diameter for the paper balloons, and from 1.2 m. up to 1.5 m. for the caouchouc balloons. The size necessarily depends on the instruments which it is desired to send up, and they must be very light.

The balloons are inflated with hydrogen in order that their lifting power may be as great as possible. They rise with great rapidity at the commencement of their flight, from 4 up to 8 m. per second, reach their highest point and return to the earth. Generally, at their maximum altitude, the caouchouc balloons explode. For that reason it is necessary to protect the apparatus and the valuable records against a destructive fall, for which is used an ingenous device. The balloon is covered with a parachute arrangement which at the moment of exploding opens and controls the speed of descent. Tandem balloons are often sent up of which only one explodes, the second remaining intact and checking the fall.

If it is desired to take a specimen of the air, the balloon carries up finely pointed tubes in which there is as nearly perfect vacuum as possible; by means of a clock-driven device the point is broken at will and is automatically closed some minutes later. Explorations by sounding balloons are being made in all parts of the world.

RESULTS OBTAINED.

At the sea-level the temperature somewhat regularly decreases in the first 2,000 to 3,000 m., often having inversions; later it cools more rapidly and regularly up to an altitude varying from 8,000 to 14,000 m., according to the locality. In French regions, at approximately the altitudes named, there usually are observed the lowest temperatures. If the investigation is carried farther upward, the temperature is generally sensibly increased (a warm layer), and later decreases again very rapidly and irregularly. This layer, where the temperature is almost constant and does not have regular variations either way, is called the isothermal layer or stratosphere.

The Pavia balloon, which was mentioned at the beginning of this article, gave similar indications; there should be mentioned also the Belgium balloon, liberated on November 5, 1908, which registered -67.8°C. at an elevation of 15,500 m., and only -63.5°C. at 29,040 m.; and that sent from Trappes on August 10, 1907, which showed -55.6°C. at 13,000 m. and -51.6°C. at 28,000 metres. This division of the temperature is found commonly everywhere, changing only according to the meteorological situation in the temperate and polar regions.

A long time ago Teisserenc de Bort showed that the altitude of the stratosphere varied with the meteorological condition: low (8,000 to 9,000 m.), and warm (-45° to -55°), during atmospheric compressions it reaches higher altitudes and becomes colder in the anti-cyclones, where it can reach a temperature of -60° to -75° at an altitude of approximately 14,000 metres.

Another very interesting fact: only seldom are temperatures as low as -80° observed over the polar and temperate zones, while that temperature often is reached and even exceeded over the equatorial regions, where the stratosphere is found only at altitudes of from 16,000 to 18,000 m.; the observations made by Teisserenc de Bort over tropical seas and over Lapland during the years 1906, 1907, and 1908 showed that for the upper regions the temperature is less cold at the poles than in the equatorial regions, although upon the earth's surface the polar temperatures are the lower by from 20 to 50 degrees. The atmospheric movements that take place at the equator produce, doubtless, powerful and sudden decreases of air pressure, which cause a lowering of the temperature.

Further, the temperature decreases more rapidly in the equatorial regions for the reason that the air is drier and it chills more completely, hence the stratosphere lies at a higher altitude; for that reason, approximately at 16,000 or 17,000 m., temperatures are observed from 20 to 30 degrees colder above the equator than over Lapland.

Finally, the various observations made it possible for the Austrian meteorologist, Hann, to determine the consistence of the air at different altitudes; and that atmosphere, the components of which were given above as for the earth's surface, is not constant; only 18 per cent. of oxygen at 10,000 m., 15 per cent. at 20,000 m., and 7 per cent. at 35,000 m., while the quantity of nitrogen becomes greater, respectively 81, 84, and 93 per cent.

It would be difficult to remain indifferent in the face of such remarkable discoveries that lead to a more complete knowledge concerning the medium in which we live, making it possible that we shall more thoroughly understand the mechanism of the air movements. We owe much to the scientists conducting these investigations.

COMPRESSED AIR ON THE AUTOMOBILE

BY C. S. COLE.

There is noticeable in the demand of the public an inevitable and sure feeling that the limitations of the electric starter are measured directly by the capabilites of the storage battery. The very high weight of this item precludes, for other than lighting the lamps, a life and service reconcilable with modern motor car development. To equip a car with a battery for lighting the lamps while the car is stopped is eminently practicable, and batteries for this service in connection with a properly designed lighting dynamo can be had which will give reasonable service for four or five years.

If electric starting is to be included in the service from the battery, and an equal length of life without the high cost of renewal and repairs is desired, the weight of a battery of guaranteed ruggedness and capacity would be such that no manufacturer or owner would sanction it, as the weight of the battery alone would very nearly equal that of another passenger.

EFFICIENCY OF THE AIR STARTER.

Recent developments in highly efficient air starting systems have pointed the way toward relief from battery maintenance and also opened up the field for pneumatic gear shifting air brakes which permit a car to be driven with all the ease a motorman controls our modern high speed electric railway trains in heavy interurban traffic. There are available in the market to-day highly efficient and compact units consisting of an air starting distributer, electric lighting generator and air pump, all within a single casing and having only one point of drive.

These starters will spin the largest motors at a speed of 200 or 250 revolutions a minute, which eliminates the past necessity of turning it over at 100 or less for ten or twenty minutes to start in cold weather. In special cases they can be adjusted to spin the motor much faster if desired for a short time. With speeds of 250 and higher an engine will start almost instantly even in cold weather because the violent suction established in the carburetor bodily pulls the gasolene into the cylinder chambers without losing it along the walls of the inlet manifold, for which reason the slower speed electric starter must turn over for a longer time and gradually work this cold fuel up into the motor.

Further, these new machines in a unit case weigh in the vicinity of only forty pounds and furnish everything needed for electric lights, air starting, pneumatic or electric gear shifting, railway air brakes, tire inflation and compressed air for cushion and upholstering blowoff. The development of a reliable method for obtaining high pressure compressed air and a system designed to hold it absoluetly without leaks has made all this possible.

AIR CUSHIONING.

Many persons are working at the present time upon various air suspensions for the car to give a resiliency sufficient of realizing liberation from the rubber tire. These machines will undoubtedly help this field of endeavor along incidentally, as the great stumbling block to date has been to get the air at high pressure with the certainty necessary in a spring suspension. While upon this vital question it may be stated that many practical engineers believe that logical solution of the tire question is transference of the compressed air in its perishable container of rubber and cotton in the tire to some metal medium between the wheels and the car.

Among many advantages of air starting is the elimination entirely of all forms of gears, chains, etc., in connection with the start. These all make noise in varying degree, while air drives the pistons down with a force of many tons in an absolutely inaudible manner. Coincidently pulling the car and starting the motor on magneto has no bad effects with air as it has with electricity, and in fact is to be recommended as of great use in the following way:

On starting from the curb the car is put in low or second and the switch thrown on magneto with the clutch in. If the air button is now pressed the modern six, or in fact any six, will pull away from the curb in a manner that defies detection from an electric car and there is absolutely no shock when the motor gets the first explosion, since the air pressure is as high as the explosion and the two shade together without difference at the crankshaft. This practice eliminates the old necessity of starting the motor before starting the car and makes a much more convenient, distinctive and rational getting away; while after the actual start the driver proceeds with his other gears exactly and unconsciously as though he had started the car with the clutch.

With the developed systems referred to this is standard practice for starting, backing and all work where the car is moved in small distances, and its realization takes a tremendous amount of work and wear off the clutch, while giving a control of the car in tight spots which is absolutely noiseless and free from that commotion under the hood usually associated with starting or traffic congestion. A six cylinder under the force of the compressed air is for the time being transformed into an unlimitedly powerful steam engine and is handled as such in a manner exactly the same as an electric car, both as to noise and flexibility, but with greater power.—*The Sun, N. Y.*

The lack of comparable and accurate statistics of coal-mine accidents in the United States has led the Bureau of Mines to collect such data, and the results of these investigations have been compiled by Mr. F. W. Horton, in Bulletin No. 69, entitled "Coal Mine Accidents in the United States and Foreign Countries," which has just been issued. Copies of this bulletin may be obtained by addressing the Director, Bureau of Mines, Washington, D. C.

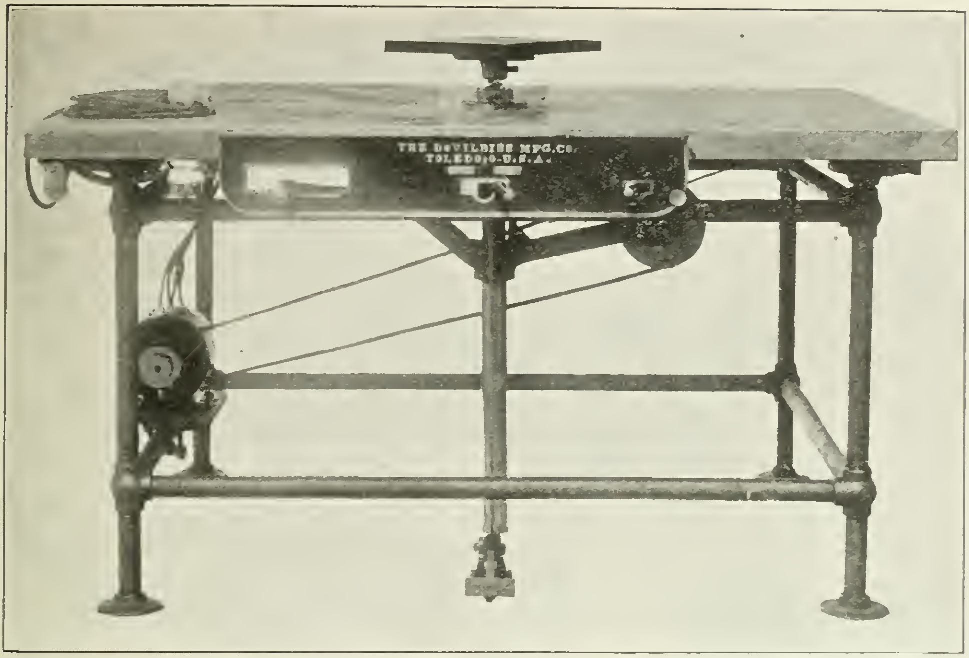

FIG. 1.

AUTOMATIC PNEUMATIC PAINTING APPARATUS

For covering comparatively small objects and parts with paint, japan, enamel, lacquer, etc., the machine shown in the illustration is very effective.

The article to be painted is placed on the elevated platform which is rotated by means of a Westinghouse small motor mounted under the table. The paint, or other material, is sprayed on by means of compressed air, thus covering the article more rapidly than can be done by brush work, reaching all parts of carvings, irregularities, etc., and showing no brush marks.

When it is necessary to remove the fumes, the revolving stand is mounted inside the hood illustrated, which is provided with a Westinghouse ventilating fan.

The device is manufactured by the De Vilbiss Mfg. Co., Toledo, O.

The number of locomotives ordered in the United States during the year 1912 was 4,515, which may be taken as a fair average figure for the period of 10 years since records dealing with the subject were instituted.

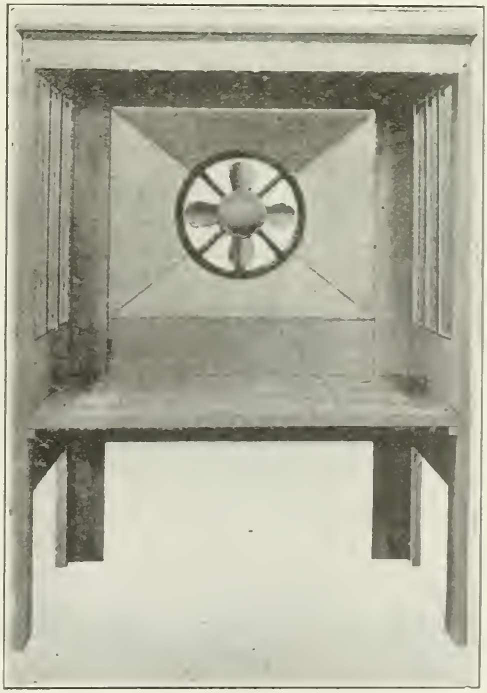

FIG. 2.

PRINCIPAL LONG TUNNELS OF THE WORLD

The *Engineer*, London, has prepared tables, reproduced upon the opposite page, of the world's greatest tunnels. Various notes are appended relating to some of the tunnels individually. It will be noticed that the United States makes a very insignificant showing in the list.

Electric traction is employed in the Simplon, Lötschberg, Ricken, and Jungfrau tunnels. Steam locomotives burning liquid fuel have been tried in the Arlberg Tunnel, which is extremely difficult to ventilate efficiently, and are exclusively used in the Caldera Tunnel. It is now proposed to electrify the Arlberg Railway between Bludenz, the great tunnel, and Landeck, a distance of 25 miles. The Lötschberg-Simplon Railway—Spiez to Brigue, 46 miles—is electrically equipped, and is the first Alpine railway with great traffic to be so worked.

Although two lines of way are laid in the Lötschberg and Arlberg tunnels, the approach lines are single.

The Mount Cenis Tunnel is hardly appropriately named, as the culminating point of the Mont Cenis lies 17 miles to the east of the tunnel, which is carried through the Col de Frejus.

The Ricken Tunnel is on the new railway from Utznach to Wattwil, 9 miles in length, which links up the industrial Toggenberg Valley with the Lake of Zurich. It is the second longest single-line tunnel in the world.

The tunel through the Col di Tenda is on a branch line from Cuneo—55 miles from Turin—to Vievola. The latter station at the southern portal of the tunnel is the present terminus of the line, which is now being extended down to the valley of the Roya to Ventimiglia, 32 miles away. The earliest mention that we have of tunnelling in connection with the Alps concerns the Col di Tenda, and dates back to the fifteenth century. Anne, Duchess of Savoy—married 1433—who was considered by her contemporaries the most intellectual woman who had ever lived, conceived the grand project of piercing this mountain, then, and for nearly two and a half centuries afterwards, the best and easiest pass available between France and North-West Italy, with a tunnel at about one-third of its height from the summit. It appears beyond doubt that the works were begun, but at the death of Anne in 1463 they were abandoned. After a lapse of three centuries they were resumed in 1782 by order of Victor Amadeus III., King of Savoy. The excavation of the mountain was continued, although not vigorously, until 1794, when it was stopped in consequence of the invasion of Savoy by the French. The total length of the tunnel would have been about 3,000 yards, and by means of it a precipitous sugar-loaf ascent of 1,300 ft. to the top of the pass would have been avoided. With some alterations this project was carried to a successful issue in 1883. The new road constructed in that year penetrates the Tenda by means of a tunnel about 1½ miles long, forming the longest road tunnel in the world. The altitude of the north entrance is 4,300 ft.; that of the south 4,196 ft. From the central point both ends are visible. The old road over the fortified heights of the Col di Tenda, where the Maritime Alps terminate and the Ligurian Alps begin, is now closed to ordinary traffic.

The Jungfrau Railway is of one metre gauge, and for most of the distance requires a rack rail, the Strub being the type employed The tunnel commences at Eiger Glacier, 7,621 ft. above datum, and extends to Jungfraujoch. The dimensions of the tunnel are:—Maximum width, 11 ft. 9¾ in.; maximum height, 13 ft. 11 in.

The Severn Tunnel is the longest subaqueous tunnel in the world.

The Turchino Tunnel is on the new line from Genoa to Asti, which has a total length of 62 miles, and a tunnel mileage of more than a quarter of that of the whole line. The gradient of the great tunnel is 1 in 83 rising from south to north.

The Albula or Engadine Tunnel lies between the two stations of Preda and Spinas. It is the highest of the Alpine series, with the exception of the Jungfrau, but the latter belongs to rather a different category.

The Peloritana Tunnel pierces the ridge sheltering Messina from the north.

The Gravehals Tunnel, on the Bergen Railway, runs through the Urhvode Mountain at a depth below its summit of 1.698 ft. At its east entrance is Myrdalen Station, and at its west entrance Opset Station. The tunnel is nearly level, rising only 55 ft. from west to east. Immediately east of Myrdalen Station is another long tunnel, the Reinunga, 1,968 yards.

TABLE I.—*Tunnels in Europe of Two Miles in Length.*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	Opened for traffic.
			M. yds.	Feet.	
1	Simplon*	Switzerland–Italy	12 458	2313	1906
2	St. Gothard	Switzerland–Italy	9 564	3788	1882
3	Lötschberg	Switzerland	9 55	4077	1913
4	Mont Cenis	France–Italy	7 1730	4248	1871
5	Arlberg	Austria	6 404	4300	1885
6	Ricken*	Switzerland	5 610	650	1910
7	Tauern	Austria	5 546	4020	1909
8	Ronco	Italy	5 277	—	1888
9	Tenda*	Italy	5 56	3260	1899
10	Karawanken	Austria	4 1683	2088	1906
11	Jungfrau*†	Switzerland	4 834	11,220	1912
12	Borgallo	Italy	4 700	—	1887
13	Severn	England–Wales	4 636	—	1886
14	Turchino*	Italy	4 10	—	1900
15	Wocheiner	Austria	3 1647	1761	1909
16	Albula*†	Switzerland	3 1150	6133	1903
17	Totley	England	3 950	—	1893
18	Peloritana*	Sicily	3 686	—	1885
19	Gravehals*	Norway	3 516	2844	1909
20	Standedge	England	3 60	—	1850
21	Woodhead	England	3 13	—	1845
22	Bosruck*	Austria	2 1693	2405	1906
23	La Nerthe	France	2 1581	—	—
24	Kaiser Wilhelm	Germany	2 1069	—	1879
25	Echarmeaux	France	2 1020	—	1895
26	Blaisy	France	2 990	—	—
27	Sodbury	England	2 913	—	1903
28	Credo	France	2 800	—	—
29	Vizzavona*†	Corsica	2 778	2971	1889
30	Disley	England	2 346	—	1902
31	Col de St. Michel*†	France	2 292	—	1901
32	Bramhope	England	2 234	—	1849
33	Festiniog*	Wales	2 206	—	1879
34	Cowburn	England	2 182	—	1893
35	Meudon	France	2 134	—	1900

TABLE I.—*Tunnels in Europe of Two Miles in Length (continued).*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	Opened for traffic.
			M. yds.	Feet	
36	Giovi	Italy	2 45	1890	—
37	Col des Loges*	Switzerland	2	3200	—
38	Cremolina*	Italy	1 1748	—	—
39	Cairasca*	Italy	1 1520	—	1906
40	Hauenstein	Switzerland	1 1210	—	—
41	Semmering	Austria	0 1333	2940	1850

TABLE II.—*The Longest Tunnels Out of Europe.*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	Opened for traffic.
			M. yds.	Feet.	
42	Hoosac	United States	4 685	—	1876
43	Khojak‡	Baluchistan	2 769	—	1892
44	Suram	Caucasus	2 750	—	1895
45	Caldera*	Peru	4 1320	15,774	1893
46	Beacon Hill*	China	1 644	—	1910
47	Transandine*†	Chile-Argentine	1 551	10,500	1911

TABLE III.—*Long European Tunnels now being Constructed.*

Ref. No.	Name of tunnel.	Country.	Length.	Summit level.	
			M. yds.	Feet.	
48	Hauenstein Base	Switzerland	5 0	—	—
49	Somport*	France-Spain	4 1512	—	—
50	Grenchenberg	Switzerland	4 0	1787	—
51	Puymorens*	France-Spain	3 317	—	—
52	Mont D'Or	France-Switzerland	3 1395	—	—

* Single-line tunnel. † One metre gauge railway. ‡ Standard gauge of India.

PRINCIPAL LONG TUNNELS OF THE WORLD.

The Standedge Tunnel, on the Huddersfield and Manchester Railways, between Marsden and Diggle stations, held pride of place as the longest in the kingdom until the Severn was completed. The original single line tunnel has been augmented by a second and also by a double-line tunnel, all abreast, driven through the "millstone grit" series of the Pennine Range. There is also a fourth tunnel, of much smaller section, at a lower level, and 114 yards longer than the above, through which flows the Huddersfield Canal, with 8 ft. depth of water.

La Nerthe, the longest tunnel in France, is ventilated by twenty-two shafts, one of which is 607 ft deep.

The Kaiser Wilhelm tunnel, the greatest work of this kind in the German Empire, is on the line Coblenz-Treves, and between the two stations of Eller and Cochem. With the rapid increase of traffic between 1895 and 1900 the air became so foul as seriously to inconvenience platelayers and passengers. It was ventilated in 1901 on the Saccardo system, as successfully applied in the St. Gotthard. This system has been installed also in the Wocheimer and other tunnels.

The tunnel under the Col des Loges is on the very steeply graded line from Neuchâtel to Chaux de Fonds. At the north end of this tunnel is a solitary station, Les Convers, and immediately beyond the line enters another tunnel, three-quarters of a mile long, under Mont Sagne. The open space between these tunnels is so short that it might almost be a shaft.

The Cairasca Tunnel is on the approach line to the Simplon Tunnel from Domodossola. It is a spiral tunnel and the longest of that type in the world, which distinction is now being erroneously claimed for the Transandine Tunnel. The difference of levels between the south and north portals of the Cairasca is 307 ft. None of the seven spiral tunnels on the St. Gotthard Railway is more than one mile in length and none makes a greater ascent than 118 ft.

The Hauenstein Tunnel is on the highly important section of the Federal Railways between Basle and Olten. The gradients on the approaches to and inside this tunnel are so steep that a base tunnel is now under construction.

The Semmering was the first Alpine tunnel. It pierces the Noric chain near the summit of the pass. The Semmering Railway, from Vienna to Trieste, was built for the Austrian Government by the engineer Carlo Chega, between the years 1848-54.

The Hoosac Tunnel, between Troy and Fitchburg, took twenty years to construct, but there were several suspensions of work.

The Khojak Tunnel is the longest in Asia. It pierces an historic pass across the Khwaja Amran offshoot of the Toba-Kakar Mountains. It is on the Chaman extension—29.35 miles—of the Sind-Pishin section of the North-Western Railway of India, which extension was built between the years 1888-91 in consequence of the fear of Russian aggression. Two lines are laid through the tunnel. The gauge is the standard gauge for India, *i. e.*, 5 ft. 6 in. When railways were first proposed in India it was considered that a gauge wider than the normal was desirable, as the narrower would be inadequate against cyclonic storms, so frequent at certain seasons of the year. The Khojak, like most other tunnels near the northwest frontier of India, is guarded at each end by strong iron gates.

The Puymorens Tunnel is on a second new Trans-Pyrenean line to connect Aix-les-Thermes, on the Mid system, with Ripoli, in Spain. The French station at the tunnel mouth is Hospitalet. Both of these Trans-Pyrenean Railways have decided to employ electric traction, and therefore steeper gradients than are practicable with steam propulsion have been introduced.

The following long tunnels are projected:—Faucille Pass Railway, Lons le Saunier to Heyerin, three tunnels, 6.6, 9.4, and 4 miles in length respectively; Mont Blanc Railway, Chamonix to Courmayeur, two tunnels, 8 and 3 miles in length respectively; Splugen Railway, Thusis-Rothenbrunnen-Chiavenna; Tunnel, 17 miles; Rigoroso Tunnel, between Genoa and Tortona, 12¼ miles.

LIQUID AIR MINE RESCUE APPARATUS

Liquid air would seem to be specially adapted for use in mine rescue apparatus. It is the most condensed form of air, representing about 800 times its own volume of gas, and the liquid evaporates into the gas by natural absorption of heat. The liquid is carried at atmospheric pressure, so that no heavy cylinder is required for carrying it.

Coming to the details of application it was no easy proposition to satisfy all the conditions. In the first place it was necessary to evolve a simple form of apparatus to control in an adequate and practical way the liquid air in a breathing dress, as also to find a suitable means for transporting the air below ground, whilst it was, of course, imperative that the plant and process for the production of the air, containing from the outset a large percentage of oxygen, should be free from complications and not unduly costly in maintenance.

The "Aerophor" apparatus, here to be spoken of, is the result of years of experiment and careful development and has not been long in active and successful employment, but is already used by many important British rescue stations a typical one being the Elsewick (Newcastle) Station. This station, in charge of first and second officers, will control a number of sub-stations which will each be in charge of a superintendent. In addition to the necessary complement of rescue apparatus, each of the sub-stations will be furnished with a fire pump of 400 gallons' capacity per min. and a tender. The fire pump at Elswick Station is of 500 gallons per min. capacity. Since the establishment of the last-named Station—three years ago—the fire calls have averaged one in every five weeks. The Station is fortunate in possessing an ideal gallery in the form of a disused clay pit, in which the air is normally so foul as to extinguish a safety lamp. The height of this gallery varies from 10 ft. to 3 ft. 6 in., and for clearing it a Sirocco exhaust fan is installed.

So far as the rescue apparatus are concerned, the equipment is distinctly cosmopolitan, practically every type being represented, and every man passing through the station is trained in the use of each, though for all serious work the liquid-air apparatus is solely employed.

THE AEROPHOR.

The "Aerophor" liquid-air dress consists of a strong canvas jacket, to the front of which the breathing bag is attached, the liquid-air container being attached to the back. This part of the jacket is lined with thick felt, and between it and the pack is an air space for further insulation to protect the wearer's body from the cold. The container is a nickel case shaped to fit the back, the interior of the case being packed with asbestos wool, which absorbs the liquid air so that it does not run out even if the container is turned bottom up. The top of the case is provided with three openings, one for the filling, one for the escape of air whilst the case is being filled, and the third for conducting the air to the breathing bag. The outside of the case is effectively insulated and enclosed in leather. The caustic potash is contained in an outer case with a hole at each end. This cartridge is only to afford a means of exceptional reserve for use under extreme exertions, and during the third and fourth hour, so that only a very small percentage of the air is breathed twice. The mask is made of a special composition of canvas and rubber. Inside, near the cushion which ensures an air-tight joint with the face, is a flexible metal band which allows the mask to be shaped to fit any face in a few seconds. The mask is held in position by four straps, which are attached to the cap, the latter being made of asbestos cloth with a thick leather pad at the top to protect the wearer's head. At Elswick Station the half mask is almost exclusively employed, and from the point of view of comfort at any rate, it certainly leaves nothing to be desired.

As the air evaporates it passes out of the pack along a tube down the side and underneath the pack to a T-piece, where it enters the circulation, and then on to the breathing bag. On its passage it gets gradually warmed up, and is merely pleasantly cool as it passes through the valve to the mask. The expelled air passes through the exhaling valve and a tube leading to the caustic-potash cartridge. Immediately before this, however, there is an escape valve which allows excess air to pass to atmosphere. In the case of violent temporary exertion rather more air than that coming from the pack would probably be required, the balance would then be made up by the exhaled air passing through the cartridge and afterwards mixing with the fresh air from the pack, and so on to the breathing bag.

A unique feature of the apparatus is its ability to supply air to a second man from the escape valve. This is accomplished by fixing to the escape valve a tube carrying at its other end a mouth-piece and nose clip. The air thus supplied, although it has been exhaled by the wearer of the apparatus, is quite good enough to be breathed a second time, as it contains from 30 per cent. to 40 per cent. of oxygen.

It will be seen that the apparatus is entirely independent of the control of the wearer, and depends for its action upon the natural law which causes the liquid to evaporate, the rate of such evaporation being controlled by the insulation between the inner pack and the outer atmosphere. This, however, is not appreciably affected by a change of from 20 deg. to 30 deg. F. in the temperature of the outer atmosphere, as the difference is always some 400 deg. F.

AIR LIQUEFYING PLANT.

The plant for the production of the liquid air is installed in a room immediately at the rear of the main building. This consists of a motor-driven three-stage compressor which draws in the air through a purifier and delivers it at a pressure of 3,000 lbs. through two cylindrical tanks, arranged in series, in which the moisture and remaining impurites are absorbed. It then passes on in part to a liquifier and in part to an expansion engine. The liquefaction is accomplished through the air being cooled in the expansion engine below the critical point, and, meeting the other air current, the liquifier turns the latter into liquid, which is collected and drawn off in a continuous stream through a tap. The power developed in the expansion engine is retransmitted to the motor by means of belt and pulley. The plant is equal to the production of 20 lbs. of liquid air per hour, at a cost of slightly less than 2 cents per lb.

The method of charging is as follows:—The complete dress is fixed up ready for wear, suspended on a spring balance slung from a tripod. The relief valve is opened and the full charge of air (10 lbs.) poured in; the funnel is then removed, the two plugs screwed down and the dress is ready for service. It may be noted that an alarm watch is carried in a pocket in the front of the jacket, and upon the back of this watch is recorded the time of charging and the length of time the charge will last. The watches, all regulated to that of the leader of the party, are set to ring at a certain time to warn the wearer to return to the base.

The liquid air used contains some 60 per cent. to 70 per cent. of oxygen. Each pound of the liquid furnishes about 12 cub. ft. of oxygen, which on a conservative estimate is calculated to give 20 minutes' supply of air, and as the nitrogen evaporates at a slightly higher rate than the oxygen, the content of the latter is a steadily increasing factor. The weight of the dress fully charged is 30 lbs., a corresponding decrease in the weight taking place as the charge of liquid air evaporates.

That the use of liquid air in the "Aerophor" apparatus does not call for any special knowledge on the part of the wearer was very graphically illustrated a short time ago, during a demonstration at the Rotherham Rescue Station, when a bricklayer's laborer was equipped with the dress. This man, without any previous knowledge of any form of breathing apparatus, performed a set task of manual labor, and on its completion was pronounced by the doctor to be in first-class condition. The man expressed himself as perfectly comfortable; he said the breathing was easy and that he had an ample supply of air.

The difficulty of transporting the liquid air has been overcome by the provision of double-walled metal vessels, with a vacuum between. The vessels, which have a holding capacity of 50 lbs., terminate in a special-shaped very thin neck, which is always open to atmosphere, as on account of its enormous expansive force it would be impossible to employ hermetically-sealed cylinders. In the vessels described the air can be transported any reasonable distance, the loss by evaporation during such transportation being of no consequence.—*Condensed from Colliery Guardian.*

BUSINESS QUACKS

But the swarm of half-baked "efficiency experts" who are seeking employment as "business doctors" on the strength of a correspondence course in some "Institute of Efficiency" or solely on their claims to expert knowledge and who ought not be trusted to doctor a cat—such men as these are rapidly discrediting the whole efficiency movement in the minds of intelligent business men. —*Exchange.*

In a recent reissue of a U. S. patent for a mechanical cashier (cash register) there are 269 claims.

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EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - - - Editor
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A YEAR OF PROGRESS IN COMPRESSED AIR

The widening use of compressed air in the arts has continued during the past year with unabated progress. In addition to minor instances, where air has enlarged its usefulness in machine shop practice, in lifting liquids and in operating all devices which are used underground, we have the extension of pneumatic power to the automobile. So far there has been perfected a compressed air starting device and pneumatic metallic spring. The starting device is no longer in experiment. Its application to an automobile affords opportunity to use air under compression for starting the engine, for pumping the tires and for cleaning purposes. Its advantage over the electric system of starting is especially apparent in cold weather, as the compressed air starter throws the engine promptly into active service, drawing the gasoline rapidly because of the rapid movement of the engine, while with the electric starter, the process being slow, like that of hand cranking, the gasoline cools and deposits so that it is not so easily sprayed and ignited.

The metallic air spring invented by Mr. George Westinghouse is now an acknowledged success in automobile service. It was originally intended to replace the pneumatic tire, then it was thought that these air springs might replace the metallic springs, but a plan seems to have been perfected by which the air spring simply adds greater elasticity to the regular spring, and in doing this it eases the shock throughout the apparatus. These air springs are upright cylinders, one of which is attached to each of the four metallic springs in such a way as to separate through an air cushion the body of the car from the axle. These springs are pumped up by the ordinary motor pump, and in this way an opportunity is given to replace leakage. A motor car equipped with these air springs may ride at full speed over a rough road without serious effect to the occupant of the car.

The most important advance in compressed air practice during the year has been in the turbo air compressor. Next we might mention the introduction of plate or lift valves of the Rogler pattern. The turbo has proven its value as an air compressor up to a little above 100 pounds pressure. Machines of this type, with steam turbines driving air impellers, have been in constant practical operation during the year, generating large volumes of compressed air with safety and with reasonable economy. The largest compressed air plant in the world is now in service generating air power for the South African Gold Mines, and the fact that this plant is being enlarged from time to time is an evidence of the success of the turbo system. In America turbo air compressors are coming into use for air at all pressures up to 100 pounds. Large installations have recently been erected for blast furnace practice, both the steam and air ends being turbines: The Tennessee Coal, Iron & Railroad Company have recently installed a machine of this class which is giving a volume of 55,000 cubic feet per minute at from 18 to 22 pounds pressure. This machine may be run either through exhaust or live steam, a regulator being supplied by which it is shifted from one to the other as the exigencies of the case demand.

Machines of this type may also be driven by electric power. Several designs have been built and are now in operation, by which electric motors of normal sizes and speeds are used to drive turbo air ends through herringbone gears, encased and immersed in oil, thus bringing up the speed of the air end so as to attain maximum efficiency. So well have these machines been designed that there is an entire absence of noise and practically no wear on the gears.

The great importance of the turbo air compressor lies in the volumetric capacity of a machine of small size and light weight. The weight of a reciprocating apparatus of equal capacity is thus practically divided by four.

Little attention is required except to start and stop the machine and the expense of oil is reduced to a minimum because the machine pumps the oil around and about the bearings, then cooling it and returning it to its original reservoir for continued use. We look to see during the coming year still further and important developments in this line of compressed air generators.

W. L. Saunders.

In the literature of ozone at present there seems to be practically no statement which is not flatly contradicted by exactly the opposite statement made by equally high authority.—*Dr. C. P. Steinmetz.*

THE MODEST DEMANDS OF THE BUREAU OF MINES

The estimates of appropriations for the United States Bureau of Mines, for the fiscal year ending June 30, 1915, as approved by Secretary Lane of the Interior Department, have just been forwarded to Congress.

For general expenses of the Bureau of Mines, $70,000.

For investigating mine accidents, $347,000.

For the equipment of mine rescue cars and stations, $30,000.

Equipment of testing plant at Pittsburgh, Pa., $10,000.

For testing fuels, $135,000.

For mineral mining investigations, $120,000.

For inquiries and investigations of petroleum and natural gas, $30,000.

For inspection of mines in Alaska, $7,000.

For books and publications, $2,000.

For lands, leases, etc., for mine rescue cars, $1,000.

The total for the Bureau of Mines is thus only $752,000, an increase over the fiscal year ending June 30, 1914, of $90,000.

The item of $30,000 for the equipment of rescue cars and stations is for the first time placed separately in the estimates and represents an increase.

The $10,000 asked for the equipment of the testing plant is a new item. The money is needed for the purchase of steam and electric equipment. The estimates set forth that the present power and electric service plant at the experiment station is on the eve of breakdown.

For the mineral mining investigations, an increase of $20,000 is asked, from $100,000 to $120,000.

For the inspection of mines in Alaska, an increase of $500 over the previous year is asked. The same increase is asked for books and publications. The item for lands, leases, etc., for mine rescue cars is decreased $1,000.

The item of $30,000 for inquiries and investigations of petroleum and natural gas is for the first time placed separately in the estimates and represents an increase. It calls for inquiries and investigations concerning the mining, preparation, treatment and utilization of petroleum and natural gas, with a view to economic development, and conserving resources through the prevention of waste.

OXYGEN PRODUCTION IN THE UNITED STATES

It is estimated by those who should know that the average production of oxygen in this country is at the rate of 600,000 cu. ft. per day. Approximately one-half of this is supplied by twelve central stations located in the larger cities, and the remainder by plants in individual works.

For welding and cutting, the oxy-hydrogen process is being rapidly developed in this country, both the steel and electric companies making extensive use of this system. The railroads, however, which are such large factors in the use of oxygen in Europe, have not yet adopted this method on any large scale in this country.

The United States government uses considerable oxygen and hydrogen in its different navy yards, but ship builders generally are just beginning to apply the welding and cutting torch in their yards. The range boiler works, tube works and manufacturers of steel barrels, boxes, etc., also are large users of oxygen. It is claimed that there is a scarcity of well-instructed welders, which is due to the fact that the art is still young.

An association recently has been organized among the compressed gas manufacturers, known as the Compressed Gas Manufacturers' Association, with headquarters in New York City. Dr. Hugo Lieber, of the Blaugas Co. of America, is president.

THE PNEUMATIC SIGNALING SYSTEM IN MINES

The importance of a good signal system at shaft and slope mines has often failed to receive the attention it deserves, until some incident has occurred to reveal the inadequacy of signal system in use. The common method formerly employed for transmitting signals between the engine room and the shaft or slope bottom, or from the mine opening to the inside workings was that by which a gong was sounded by pulling a wire, or by making an electrical connection through a wire conductor.

The defects and petty annoyances arising from these systems are numerous. Wires are broken, or false signals are given by falling material coming in contact with the wire; or by someone meddling with the wire by which the signal is transmitted. The spirit of mischief, always prevalent among irresponsible men and boys in mines, has resulted, in some instances, in serious accident due to the meddling with signal wires, which is possible in both of the old systems of signaling.

Much annoyance is also caused by the corrosion of the wires and connections. There is always the possibility, also, that the proper signal may fail of transmission at one or more points, which would prove a source of danger. Interruptions are at times caused by the freezing tight of the wires, or the short-circuiting of the electric current, at intermediate points.

The pneumatic signaling system is devoid of all these defects and possesses the further advantage that the pipe line through which the signals are transmitted can be made to serve as a speaking tube. The system permits of no interruption or meddling at intermediate points, except as the pipe line may be broken by a heavy fall. A pneumatic system of signals properly installed is practically free from any expense for maintenance, during the life of the mine. One of its chief advantages is the fact that it cannot get out of order through disuse; but is always ready when required, after a season of idleness. At such times, an electric system of signaling requires much attention to again put it in shape for use. The pneumatic system is also more exempt from damage in case of fire than either of the other systems of signaling.

The pneumatic system is in use in many of the mines of the Lehigh Valley Coal Co., and it is stated that the Delaware & Hudson Coal Co. have recently decided to install this system in their mines. The same system is in use in the mines of the Oliver & Snyder Steel Co. and in a number of mines throughout the West.—*Coal Age.*

MOVING PICTURES OF A WELSH TIN MINE

It was refreshing to see in a Cinema Theatre a demonstration, at once so interesting and instructive, contrasting as it did most vividly with the nonsenical performances which are ordinarily given in these places of entertainment. And yet, the effect was somewhat novel —when tableaux of the operations at the Dolcoath mine were presented to the accompaniment of slow music, as in a transpontine melodrama. To do the "slow music" justice, however, it seemed almost to keep time with the rythmic movement of the air compressor which was graphically shown upon the screen, though we missed any representation of the stamps which are almost as necessary to a mine as Hamlet is to the tragedy of that name. A wonderful effect was produced by the passing of a Great Western train under the bridge which separates the line from the actual Dolcoath workings. Equally good was the representation of the roasting of ore in the revolving calciner, and the panoramic effects were also admirably produced. The rock drill display was particularly interesting, and loud cheers followed the admirably reproduced work of the Dolcoath ambulance brigade. Had the films been prepared a few years ago, they would have shown women at work at the buddles, but, yesterday, only one old Cornish woman, the survival of the fittest, was seen at work in the tin yard. The exposition practically concluded with the finished tin going in bags from the mine to the smelter. Another interesting reproduction was "Pay Day at Dolcoath Account House," where 1,300 miners are wont to receive their wages, most of whom go away in the act of counting, to see that they have "the right change."

CRYSTALLIZATION OF STEEL

In a paper read before the September meeting of the British Iron & Steel Institute, F. Rogers takes exception to the common assumption that machine members and other parts of iron or steel have broken as the result of becoming "crystallized through fatigue." The writer has made an extensive study of this subject and reached the conclusion that seldom, if ever, does the structure of the metal become more coarsely crystallized as the result of a load applied intermittently. It appears probable that this idea has arisen from the fact that the fracture of test samples subjected to fatigue tests are frequently of a crystalline character, but an examination would generally show that this crystalline structure is no more pronounced at the point of fracture than it would be at other points in the bar which were not subjected to fatigue.

This is a matter of the greatest importance to the rock drilling interests, and it is to be hoped that something more definite and conclusive may be evolved from the discussion which should follow the above paper.

ATMOSPHERIC CONDITIONS—SMOKE, HAZE, FOG*

BY ALFRED H. THIESSEN.

Unless one studies and observes the phenomena of smoke, haze and fog very carefully he will oftentimes not distinguish one from the other. Haze is generally supposed to consist of minute dust particles suspended in the atmosphere. I say generally, because some have advanced the theory that haze consists of condensed water vapor on dust near the earth's surface, but as haze is very prevalent in autumn, when relative humidity is quite low, it does not seem probable that condensation can take place on such a large scale. Haze exists in the upper as well as in the lower layers of the atmosphere, but when in the upper layers it consists of minute ice particles, and resembles a cirrus cloud, or it is composed of dust from meteors or from volcanoes. The haze near the earth's surface is probably caused by the dust of the earth being blown about. Haze is prevalent in autumn; the drying leaves at that time probably add to the source of dust.

Smoke, as we all know, is the product of the chimneys. It is composed of the unburnt products of coal mixed with some gases, among which are water vapor, carbon dioxide and sulphur dioxide. Clouds and fogs are formed by exactly the same processes, the cloud being an elevated fog and the fog being a low cloud. When air becomes saturated with moisture, some of that moisture condenses and forms cloud or fog. We distinguish between light haze, smoke or fog. If smoke or fog obscures an object one thousand feet away, it is called dense. Otherwise it is light.

It is usually said that fog or cloud is formed when the air becomes saturated or supersaturated; but this is not the whole story. To carry the explanation further we usually go back to the basic work of John Aiken. This experimenter was led to a line of inquiry which is very interesting to the meteorologist. He noticed that water never froze unless it was cooled to 32 degrees *and in contact with some other ice particles.* Also that water did not boil unless there was a free surface. If the heated water were covered with a layer of oil it may be far above 212 degrees without boiling. Reasoning from this it occurred to him that steam would not condense unless there was a free surface on which to condense. The sides of the vessel containing the steam would act as a free surface, and steam condenses readily on them. The experiments showed that condensation in the form of cloud took place very readily when the air contained dust, but that no cloudy condensation took place when the air was filtered so as to be free from dust. Cloud is formed by the cooling which air undergoes when expanding. It is cooled below the dew point and condenses on minute solid particles. Fog is formed by the cooling of air below its dew point, but the cooling is brought about by radiation or by the transportation of air from a warmer to a colder region.

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*Utah Society of Engineers.

If no dust existed upon which the moisture could condense the condition would be very different from that which we know. The moisture would condense on all exposed objects. Trees, houses, and so forth would be dripping with moisture. Our clothes would soon become saturated and umbrellas would be useless. Even rain coats would not avail much as the moisture would condense on one's face and flow inside his collar. And this has actually been observed in cases where the air was practically free from dust and at the same time moist.

The records of the United States Weather Bureau office at Salt Lake City show a much greater per cent. of sunshine in summer than in winter. In summer it reaches as high as 83 per cent. in July and falls as low as 43 per cent. in December and January. Likewise cloudy and rainy days are more prevalent in winter than in summer, and humidity follows the same general characteristics, the greater *relative* humidity occurring in winter and the least in summer. A tabulation of the number of foggy and smoky days since the station was established shows that the greater number occur in November, December, January and February. A period from April to September, inclusive, is practically without fog or smoke as far as the records show.

Analyzing the records for the past twenty years we find an appreciable greater number of foggy days in the last decade. It seems, then, that with the growth of the city the foggy days have kept step with it. As smoke gives an abundant number of particles on which the water vapor in the atmosphere can condense, it is logical to assume that in any city the fogginess will increase as the consumption of coal increases. The condensation of water vapor also facilitates the radiation of heat at night and thus aids the formation of fog. The following table shows how fogs have increased with the size of the city of London.

Year.	Annual Number of Foggy Days.
1871—1875	50.8
1876—1880	58.4
1881—1885	62.2
1886—1890	74.2

The hazing effect of water vapor in the air is not due to simply its presence there, but its presence in the company with dust particles. Dust particles seem to have the property of making water vapor condense upon them even when the air is not saturated, but of course the effect is greater as saturation increases, and is proportional to the relative humidity.

The amount of dust and consequently the amount of fogs depend also upon the direction and velocity of the wind. It has been frequently observed that a strong northerly wind will clear the city of fog very quickly. But a wind of the same strength from the south will not have the same effect. This is because the southerly wind must work against gravity in blowing up against the benches, while a northerly wind works with gravity.

Fog is dissipated by the sun. This being so, one can see that a fog will last longer in a smoky atmosphere than in a clear atmosphere. That is, fogs, under the same condition in a city and country will be dissipated more quickly in the country than in the city. There is still another difference between country and city fogs. The country fog particle is made up very much the same as a cloudy particle which has a tendency to rain itself out of existence, but a city fog is persistent and has little tendency to fall.

In conclusion, then, it may be said that city fogs increase as the city increases. This is because of the greater amount of dust particles thrown into the air by combustion and other means, thus giving water vapor a surface upon which to condense. That fogs persist in a city more than in the country is due to their formation, and to the presence of smoke which does not allow the sun to evaporate them. The number of the cloudy days has a direct effect not upon the number of fogs but upon their persisting after sunrise, allowing the fog to persist much longer than if it were exposed to the sun's rays.

NOTES

A fire-damp whistle has been invented in Germany, the principle upon which it works being that the tone of the whistle depends upon the density of the medium in which it is blown. The whistle is a metal cylinder, 10x2½ in. diameter, operated by an air compressor. An explosive condition in a mine is reached when the air is adulterated with about 5½ per cent. of firedamp, and demonstration to show whether this lighter-than-pure-air mixture will produce a whistle tone sufficiently different from normal to be detected by the ear is awaited with interest.

In Norway 12 years ago there was practically no production of electricity worth mentioning, but the horsepower now generated or being developed is approaching half a million. The practice has been to harness existing waterfalls or to dam natural lakes. Johan Haare, of Trondhjem, has worked out a completely new project which consists in the construction of an artificial lake as a reservoir for a small river, the Surna, in Nordmöre. The course of the river is to be altered by leading the water through a tunnel in a mountain a distance of two miles, thus obtaining a considerable fall. About 50,000 hp. will be made available.

By asking Congress to provide better for the Bureau of Mines, and even to enlarge its scope, President Wilson shows, in his message, that he realizes the true importance of mining in the general prosperity of these United States.

The superiority of American mining machinery is becoming generally recognized throughout the republic of Chile. This fact is indicated by the increased importations from the United States and the falling off of shipments from Germany and England. During the past 3 months, orders have been placed for larger amounts of machinery than ever in the history of the industry in the country. It is estimated that fully 85 per cent. of these orders went to the United States.

Some of the steam whalers that carry on the whale fishery off Tierra del Fuego are equipped with steam-driven compressors, and when a whale is killed and the tow line attached, a hollow lance tube with a hose attached is thrust through the blubber and the air compressor started. This inflates the carcass of the whale and facilitates towing it to the station where the try works are situated.

The Lake Champlain division of the N. Y. State Barge Canal is rapidly nearing completion, thirty-two miles being finished and twenty-three miles requiring some dredging. When the new dam at Troy is completed the new work will be navigable for 1,000 ton barges.

In using alcohol for a nonfreezing solution, it is found that when mixed with water, a mixture of 20 per cent. alcohol will not freeze above 10 deg. F., 30 deg. above zero F., 35 per cent. above 10 below zero, 40 per cent. above 20 below zero, and 50 per cent. above 35 below zero. The alcohol best fitted is not wood alcohol, but what is known to the trade as pyro alcohol, which is the ordinary alcohol, rendered unfit for drinking.

Two German chemists, after a series of experiments, have come to the conclusion that one coat of paint is a better protection for iron work than two or three coats, because the single coat is more elastic and less liable to crack or peel off. We are not told what paint was used.

To use ethyl alcohol as a carbon remover in automobile and other internal combustion engines, for which service it has been proved to be of great service, the best practice is to pour a half to a full wineglassful into each cylinder at night on shutting down, and let it remain until morning. To start up the engine, open the throttle wide and blow out the loosened carbon, which will have been made soft and flaky by the action of the alcohol.

Metal-shaving dies operate badly on some materials, drill rod, for example; when pressure is applied steadily, the metal is torn and left rough, but when the impelling force is applied as a series of blows, smooth cutting action results. Hence, the use of the pneumatic hammer to perform a shaving operation on drill rod that was found to be impossible when the power was applied by a press. —*Machinery.*

No other feat in the history of the oil industry has equalled the killing of the wild gas well near Oil City, La., that has been wasting from 10,000,000 to 20,000,000 cu. ft. of gas a day for the last 6 years. This great loss was stopped by the boring of a relief well close to the old well. When this well reached the same depth water and then mud was forced into the relief well under heavy air pressure. This soon chocked the gas stratum and shut off the flow. The work was done under the direction of the Louisiana state conservation commission which furnished a portion of the funds for the work. The remainder was furnished by gas and oil companies operating in Caddo parish. As soon as the flow of gas had been stopped, the well was cemented. The well had made a crater 225 ft. in diameter and 50 ft. deep.

The first time it was that I did ever make the ascent in the balloon took happening at Paris, and oh, I do wish never again it is to rise so high in the world. Up, up, up, we went until it did cross my mind that it must be to the heaven we were steering, and then, of the sudden, I did think of what would happen if the balloon it did go, as you say it "pop." And my heart it did thump, thump, thump, like the man who beats the carpet, and I felt it to be sure that I would never come down to the earth with a safe limb. But there is an end to all the things and enfin, at last, the balloon did get to the earth, and my anxiety it was over for the good and all.—*Gaby Deslys.*

A small electric fan just on the market has, attached to the motor, a concealed atomizer which adds perfume to the air current, and at once spreads it through the apartment.

A mixture of oil-gas and air begins to be explosive when the proportions are: gas, 7; air, 93. It is most explosive when the proportions are: gas, 15.4; air, 84.6; and the mixture begins to burn without explosion when the proportion is: gas, 24.5; air, 75.5.

A drawing had been made with the dimensions 12", but when sent into the shop the dimensions had mysteriously changed to 1.2". Investigation showed that a fly was repsonsible for the decimal point.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 4.

1,077,286. MEANS FOR STOPPING TRAINS. WILLIAM T. B. McDONALD, Granby, Quebec, Canada.

1,077,309. METHOD OF PREPARING ALUMINUM SULFATE. HEINRICH F. D. SCHWAHN, Belleville, Ill.

3. The method of preparing aluminum sulfate, which consists in treating sufficiently wet aluminous materials with sulfurous anhydrid and *ozone or ozonized air,* thus transforming the aluminum content of those materials into a sulfate and the iron content of such materials into a basic ferric salt, then lixiviating the resultant mass with water, and then separating the dissolved aluminum sulfate, the basic ferric salt with other insoluble ingredients contained in the aluminous materials remaining as a residue, thus producing a pure aluminum sulfate.

1,077,472. PNEUMATIC SPRING. JOSEF HOFMANN, Baumaroche, Switzerland.

1,077,509. WAVE-MOTOR. RICHARD A. BEMIS, San Bernardino, Cal.

1,077,521. APPARATUS FOR MEASURING THE VELOCITY AND INCLINATION OF THE WIND. HANS GERDIEN, Halensee, near Berlin, and RAGNAR HOLM, Charlottenburg, Germany.

1,077,584. VALVE-MOTION FOR ROCK-DRILLS. LEWIS C. BAYLES, Johannesburg, Transvaal.

1,077,697. VALVE FOR CONTROLLING COMPRESSED AIR. ALBERT J. GATES, Chicago, Ill.

1,077,724. ENGINE. JOHN D. KNEEDLER, Sioux City, Iowa.

1. In a combined compressor and motor, the combination of a casing having an inlet and outlet adapted to communicate with a storage tank through said inlet and outlet, said casing being also provided with an exhaust outlet, a rotor in the casing, a check valve in the first said outlet, a suction inlet communicating with the first said inlet, a three-way valve at the junction of the first said inlet and the suction inlet, a valve for controlling the exhaust outlet, and means for simultaneously actuating the last said valve and said three-way valve, so as to transform the combination into a motor or a compressor alternately.

1,077,803. OIL-FORGE FOR DRILL-STEEL. WILLIS W. CASE, JR., Denver, Colo.

1,077,856. PNEUMATIC FEED AND RETURN ROCK-DRILL. EBENEZER R. RAY, Placerville, Cal.

1,077,887. LOCOMOTIVE-GRATE SHAKER. FREDERICK W. MARTIN, New York, N. Y.

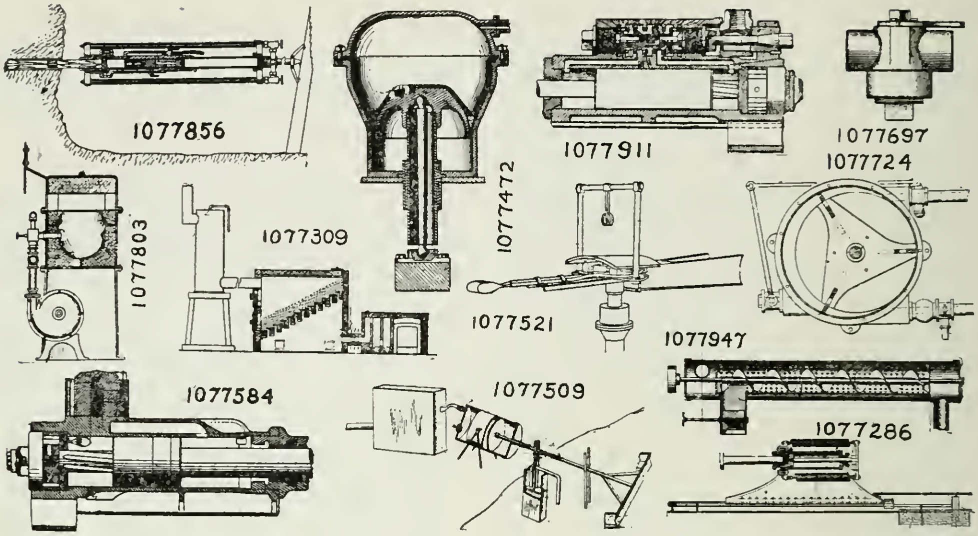
1,077,911. ROCK-DRILL. CHARLES A. HULTQUIST, Los Angeles, Cal.

1,077,947. VACUUM-CLEANER. ERLE L. ABRAMES and JOE H. CORYELL, Hayward, Okla.

NOVEMBER 11.

1,077,997. AIR LIFT-PUMP. THEODORE PETERS, Ferdinand, Ind.

4. An air lift pump comprising in combination, a pair of water cylinders communicating with a source of supply of water, each cylinder having an air pressure intake and an exhaust, rocking levers mounted upon a single pivot and one lever being provided with means for control-



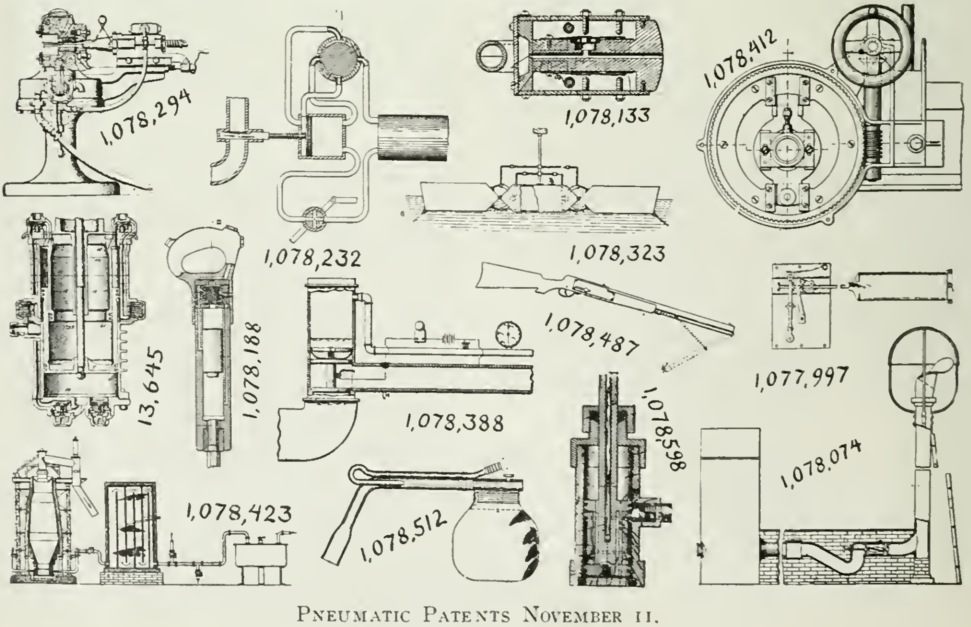
Pneumatic Patents November 4.

ling the air intakes and the other lever being provided with means for controlling the air exhausts, and a float in one cylinder for rocking said levers to alternately close air exhausts and intakes of said cylinder, substantially as described.

1,078,028. LIQUID - DISPENSING DEVICE. Harold Roscoe Zeamans, New York, N. Y.

1,078,074. MOTOR. James Vinson, Tunnel Hill, Ill.

The combination with an air receiving casing, an upwardly extending air shaft, a flue connecting the casing with the lower portion of the shaft, a rotor within the flue, of arms fixedly connected to the air shaft and extending upwardly therefrom, an imperforate semi-spherical dome-like shield supported by the arms and over the air shaft, a hood mounted for rotation upon the upper end of the air shaft and below the shield, and a vane carried by the hood and located under and projecting into the semi-spherical shield and in the path of a direct current of air passing between the air shaft and the shield, to hold the outlet of the hood out of the wind, said shield constituting means for creating a whirling action of a portion of the air current passing under the shield.



Pneumatic Patents November 11.

1,078,133. PNEUMATO-ELECTRIC TRACKER-BAR FOR MUSICAL INSTRUMENTS. CHARLES W. DORRICOTT, Philadelphia, Pa.

1,078,185. VACUUM CLEANING DEVICE. ALFRED BEST, Salt Lake City, Utah.

1,078,188. PERCUSSIVE TOOL. WILLIAM CLEMENT, Phillipsburg, N. J.

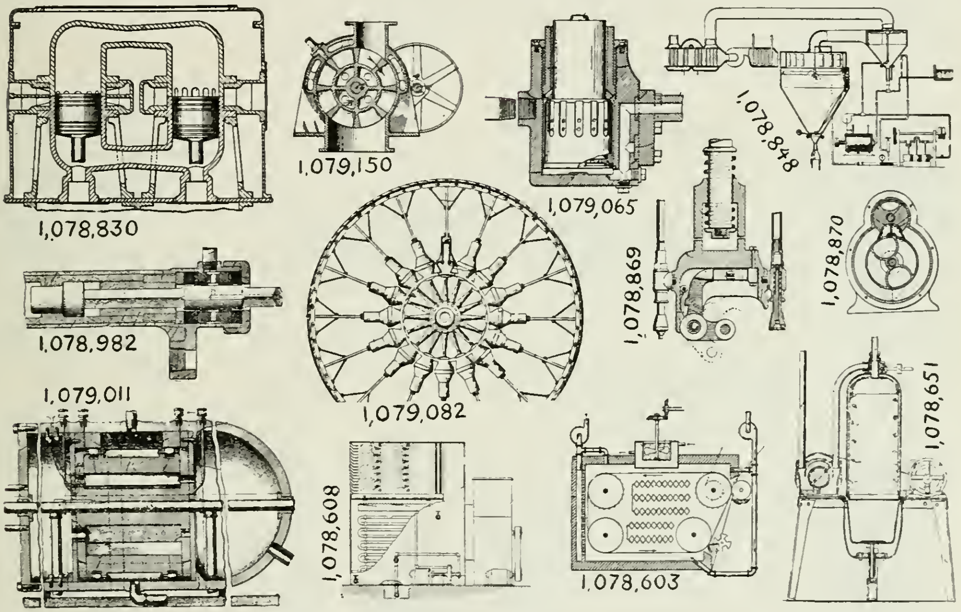
1,078,232. SUPPLEMENTAL CONTROL FOR MOTIVE POWER. CHARLES A. WILLARD, Madison, Conn.

1,078,294. DRILL-SHARPENING MACHINE. JOHN GEORGE LEYNER, Denver, Colo.

1,078,295. DIE FOR DRILL-MAKING MACHINES. JOHN GEORGE LEYNER, Denver, Colo.

1,078,303. TRIPLE VALVE FOR AIR-BRAKES. SPENCER G. NEAL, Los Angeles, Cal.

1,078,323. WAVE-MOTION MOTOR. LYMAN A. TRULL, Manchester, N. H.



PNEUMATIC PATENTS NOVEMBER 18.

1. A wave motor, comprising a floating tank, a float movably connected therewith, and oppositely-acting fluid compressors arranged between and operatively connected to the float and tank.

1,078,329. PUMP FOR VACUUM-CLEANERS. IRVING BARKER, Springfield, Ill.

1,078,388. AUTOMATIC FIRE-EXTINGUISHING APPARATUS. LANSING VAN AUKEN, Watervliet, N. Y.

1. In an automatic fire extinguishing apparatus, water distributing pipes, an air chamber, air supply pipes, a valve in said air chamber controlling the supply of water to the water distributing pipes, an expansible member and an expanding member therefor on said valve and means normally forcing them apart, substantially as described.

1,078,384. PNEUMATIC HAMMER. GEORGE LAWSON ROBERTSON, Philadelphia, Pa.

1,078,397. PNEUMATIC CLEANING-MACHINE. MORRIS S. WRIGHT, Worcester, Mass.

1,078,412. BLOWPIPE APPARATUS. WORTHY C. BUCKNAM, Jersey City, N. J.

1,078,423. APPARATUS FOR OBTAINING NITROGEN FROM THE ATMOSPHERE. OTTO FRANK and OSKAR FINCKE, Berlin, Germany.

1. An apparatus for obtaining nitrogen from the atmosphere, comprising a compressed air receptacle, an air tight receptacle, lined with copper, copper baffle plates mounted in the air tight receptacle, a body of copper supported in the receptacle, a pipe communicating with the boiler and the receptacle, a valve in the pipe, a steam inlet pipe communicating with the aforesaid pipe, a valve in the steam pipe, a furnace, a pipe communicating with the furnace and the receptacle and a valve in the latter pipe.

1,078,487. AIR-GUN. ARTHUR V. DICKEY, Seattle, Wash.

1,078,512. PNEUMATIC AGITATOR AND CLEANER. ALBERT W. MILLS, West Orange, N. J.

1,078,542. VACUUM-DREDGER. LAWRENCE B. GRAY, Boston, Mass.

1,078,595. PNEUMATIC GOVERNOR. BURTON S. AIKMAN, Chicago, Ill.

1,078,598. PNEUMATIC MOTOR. THOMAS A. DELANEY, Chicago, Ill.

13,645 (Reissue). AIR-COMPRESSOR. LOUIS G. STONE, London, England.

NOVEMBER 18.

1,078,603. MACHINERY FOR DRYING MILK AND SIMILAR FOOD. JENS OLE ANTONIO AMUNDSEN, Stavanger, Norway.

1,078,608. AIR-COOLING APPARATUS. WILLIS H. CARRIER, Buffalo, N. Y.

1,078,651. VACUUM CLEANING APPARATUS. THOMAS J. WINANS and DANIEL M. WINANS, Binghamton, N. Y.

1,078,661. FLUID-PRESSURE ENGINE. ALAN ERNEST LEOFRIC CHORLTON, Manchester, England.

1. In a valveless fluid pressure engine, two cylinders placed side by side, open communicating passages between both ends of the cylinders, inlet ports midway of one cylinder, exhaust ports midway of the second cylinder and a double acting piston in each cylinder, one of the said pistons being given a lead with respect to the other.

1,078,688. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. CALISTO J. MONFREDINI, Boston, Mass.

1,078,830. FLUID-PRESSURE ENGINE. Alan Ernest Leofric Chorlton, Manchester, England.

1,078,848. APPARATUS FOR DESICCATING LIQUIDS. Chester E. Gray, Eureka, and Aage Jensen, Oakland, Cal.

1. An apparatus for recovering the constituent solids of liquids, embodying a desiccating chamber having a converging bottom with a discharge therein for desiccated material, means for introducing heated air tangentially into said chamber and withdrawing the same centrally, whereby cyclonic currents are set up in the chamber, and means for atomizing the liquid into the chamber at a point remote from its side walls and in proximity to the air exit.

1,078,869. ANTOMATIC AIR-VALVE CAR-COUPLING. George E. Muth, Mansfield, Ohio.

1,078,870. DEVICE FOR PUMPING AIR OR OTHER FLUID. Gustaf W. Nyquist, Minneapolis, Minn.

1,078,952-3. HAMMER - DRILL. William Prellwitz, Easton, Pa.

1,079,378. SUCTION-CLEANER. Joseph H. Templin, Philadelphia, Pa.

1,079,398. VACUUM SEPARATING - TRAP. William F. Coakley and Josiah S. Levene, Kansas City, Mo.

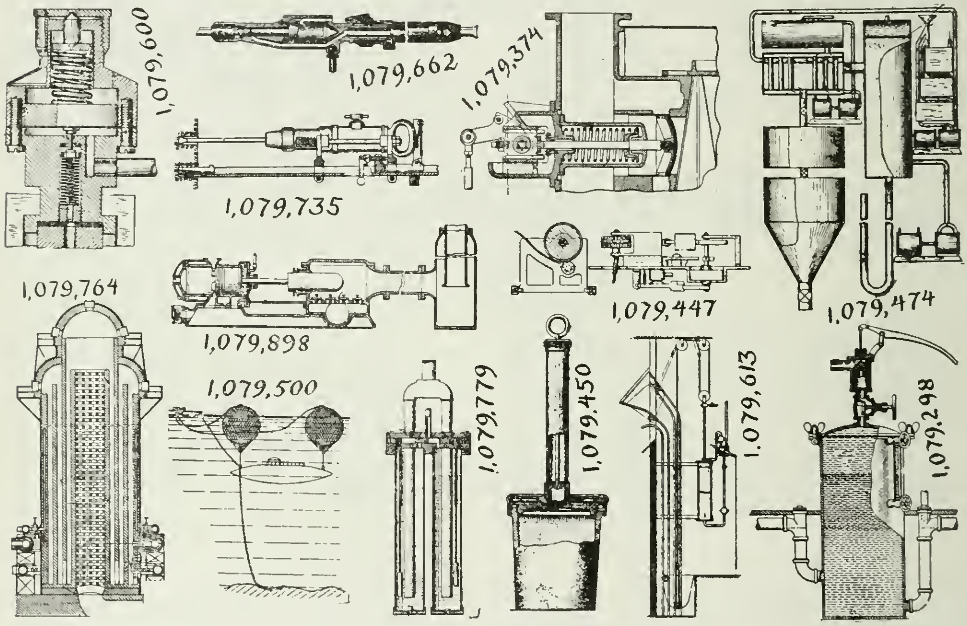
1,079,447. PNEUMATIC PRINTING MECHANISM FOR TYPE-WRITERS. Max Soblik, Dresden-Klotzsche, Germany.

1,079,450. VACUUM-PACKAGE AND MEANS FOR SEALING SAME. Gray Staunton, Muskegon, Mich.

1,079,474. PROCESS OF MAKING COFFEE EXTRACT. John T. Davis, San Francisco, Cal.

1. The method of preparing coffee extract which consists in infusing roasted pulverized coffee berries with hot water at a temperature of 165° F., and then evaporating the water therefrom by the application of heat at a temperature of 165° F. to the mixture *at less than atmospheric pressure.*

1,079,500. APPARATUS FOR RAISING SUBMERGED BODIES. Georges Lesourd, Paris, France.



Pneumatic Patents November 25.

1,079,011. GAS GENERATOR AND COMPRESSOR. Frederick D. J. Kaessmann, Coffeyville, Kans.

1,079,065. PIPE-PEENING MACHINE. John I. Pilston, Wyandotte, Mich.

5. A pneumatic tool, having in combination, hammer operating mechanism, a swiveling pipe line connected therewith for furnishing the operating medium, the said pipe line being connectible with the hammer-operating mechanism at more than one point for the purpose of giving said hammer varying radii of action, substantially as described.

1,079,082. PNEUMATIC VEHICLE-WHEEL. Joseph U. Wells, Fallen Leaf, Cal.

1,079,150. VACUUM-VALVE. Oliver S. Sleeper, Buffalo, N. Y.

1,079,311. PNEUMATIC-DESPATCH APPARATUS. Thomas Bemis, Indianapolis, Ind.

NOVEMBER 25.

1,079,374. DISCHARGE-VALVE GEAR FOR BLOWING-ENGINES. Carl G. Sprado, Milwaukee, Wis.

1,079,547. DRYING PLANT. Giovanni Falchi, Marseille, France.

1,079,600. FLUID-PRESSURE-REGULATING GAGE. Guy L. Kennedy, San Francisco, Cal.

1,079,613. AUTOMATIC - RETURN FLUID-OPERATED DEVICE. George F. Steedman, St. Louis, Mo.

1,079,662. FLUID - PRESSURE - OPERATED TOOL. Caid H. Peck, Athens, Pa.

1,079,735. PNEUMATIC ROCK-DRILL. Eduard Altenhoff, Oberhausen, Germany.

1,079,764. AIR-BLAST HEATER. Edmund Hohmann, Stettin, Germany.

1,079,779. PUMPING APPARATUS. Pearl A. Little, Frederick, Okla.

1,079,898. APPARATUS FOR PUMPING LIQUIDS. Thomas M. Chance, Philadelphia, Pa.

1,079,908. AIR-GUN. Adolph Wissler, St. Louis, Mo.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIX FEBRUARY, 1914 No. 2

AIR LIFT PUMPING

BY JAMES P. GILLIES.

Most of the data which we have concerning the air lift are rather the results of direct experiment than of deductions from a scientific viewpoint. Air lift operations have never been plotted on curves, and the people who can best tell you how to obtain the finest results are those who have had the widest experience in pumping water by this means.

AIR LIFT REQUIREMENTS.

There are three principal things necessary for an air lift. The first and usually the most expensive of these is the well to yield the water; next the compressor to furnish the air to pump the water; and, lastly, the pipe to carry the air down and the water up. Each of these three, to give the best efficiency, must be of proper size and design.

THE WELL.

A most common mistake in the well has been the drilling it too small. A great many of the wells which are encountered start out bravely with a 10, 12 or even 14-inch hole and end up with 5, 4 or even 3-inch diameter. This is due to two causes. In the first place most of these wells were originally designed for the installation of a pump of the sucker rod and barrel type. The large hole was necessary for their installation, but the yield of the pump in proportion to the space it occupied was small and so a much smaller hole lower down was permissible. Secondly; in the process of drilling difficulties are often encountered which make it necessary from the driller's point of view to reduce the diameter. Later the water level dropped so, that the pump was no longer of service without reaming the well; or more water was required than the pump would yield and so the air lift was resorted to.

THE AIR COMPRESSOR.

A most important thing to begin with is the selection of a proper air compressor, and this must be determined largely by local conditions. It may be either of the straight line or duplex type with single or multi-staged air end. It may be either direct steam, motor or power driven. If steam, it may be either simple or compounded. If motor or power driven either direct connected or belted. Gear drive is not advised because of the nature of the duty to be met.

PIPING THE WELL.

The proper piping of the well is very important and it is here that experience and the intelligence or otherwise of the designer comes most into play. He must determine the proportioning of the air and water piping and the proper submergence at which to introduce the air into the water column, as well as the best method of doing it. There are three different methods of piping a well, as shown in Figures 1, 2 and 3. Figures 1 and 2 are those most commonly used. Where the well is large enough in proportion to the demand for water, No. 1 should always be used. Where the greatest possible yield of water for a given diameter of well is required than No. 2 is resorted to, but only at a sacrifice in operating economy.

AIR LIFT HANDICAPS.

It can be seen from the foregoing that there are a great many variables to be considered in the installation of a really efficient air lift.

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*Paper before American Society of Brewing Technology, Chicago, Nov. 20, 1913. Somewhat condensed.

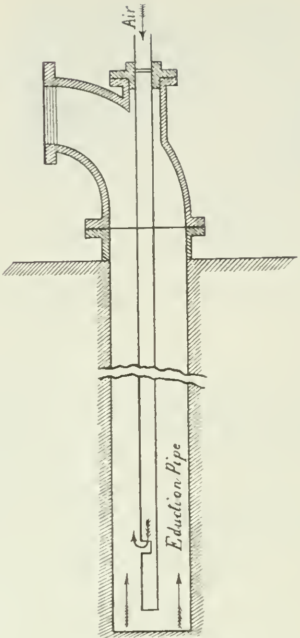


Fig. 2

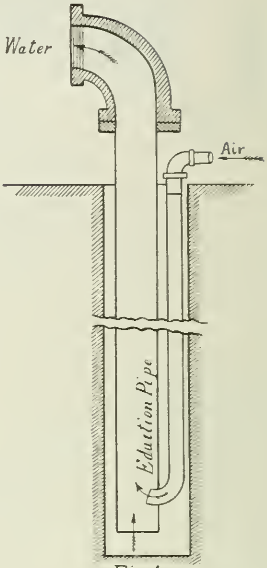
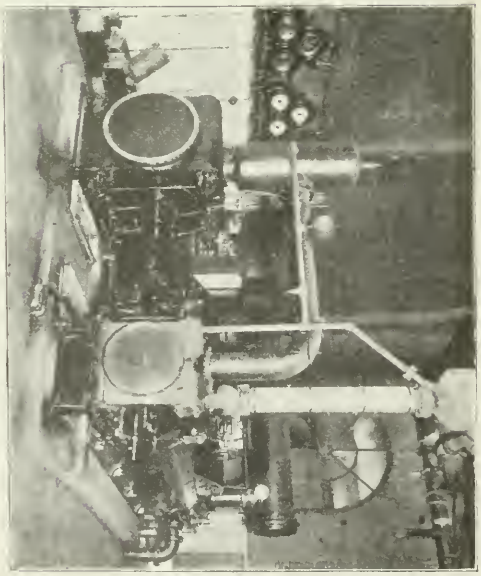


Fig. 1



COMPRESSOR AT SULZBERGER & SONS.

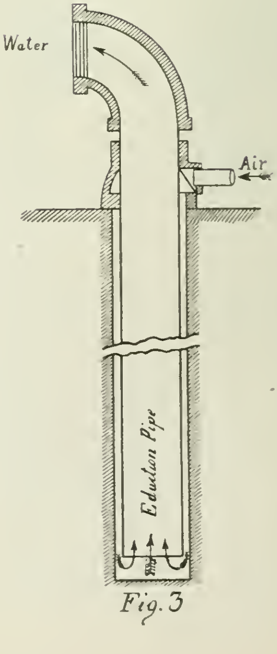


Fig. 3

This method of pumping has long been considered, because of its reliability and the general acknowledgment that it would obtain the greatest quantity of water from a given sized well. Even those who have installed it have, however, done it in an apologetic manner, making excuses for its inefficiency. This reputation is due to the fact, as already stated, that the air lift has been usually the last resort, installed under conditions that have handicapped it, whereas other systems of deep well pumping are given every advantage from the start. Then, too, with a pump it will either work as designed or not work at all, while the air lift will give some kind of result even when installed in a haphazard manner.

MODERN PRACTICE.

Within the last few years, however, the air lift has been coming into its own, until to-day those who know admit that, properly installed, the air lift compares very favorably in operating economy with any other method of deep well pumping. The high efficiencies now obtainable are due to the high state of perfection to which the air compressor has been brought, to the better method of introducing the air into the eduction or water pipe and to the proper proportioning of the pipes themselves.

DEFINITIONS.

Static head is the distance from the level of the water in the well to the well head or level of the ground when the well is not pumping.

Drop is the distance which the water recedes when the well is delivering a certain definite quantity of water.

Elevation is the distance above the well head to which it is desired to deliver the water.

Lift consists of *static head* plus *drop* plus *elevation.*

Submergence is the distance below the water level at which the air is introduced into the water column. It is styled either *starting submergence* or *running submergence.* The distance from the point where the air is introduced into the water column to the final point of discharge is considered as 100%. Thus 60% submergence means 40% lift, or 30% submergence 70% lift; the amount and percentage of submergence depending directly upon the height of lift. These different points are graphically illustrated in Figure 4.

THE MODERN AIR LIFT.

The modern air lift is so arranged that a constant stream of air and water is mingled, the air being broken up into small globules and distributed through the water, this resulting in a constant discharge with a minimum amount of slippage.

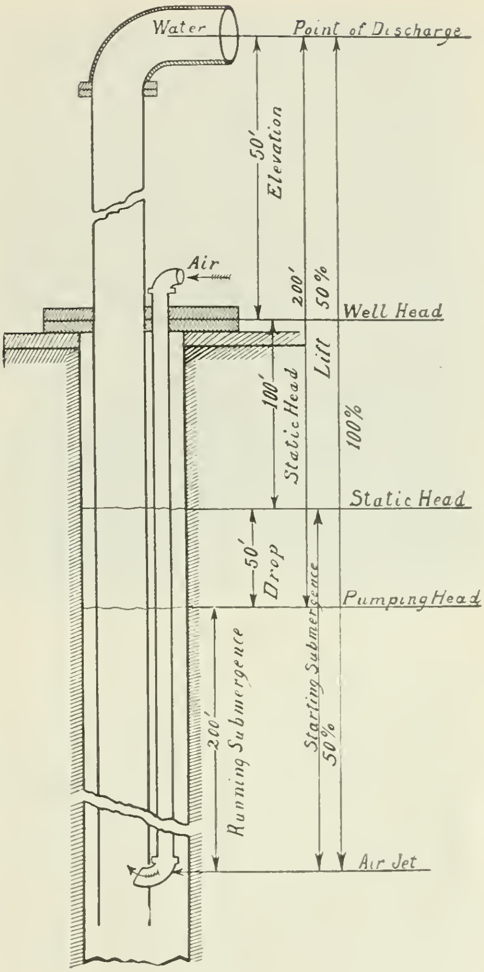
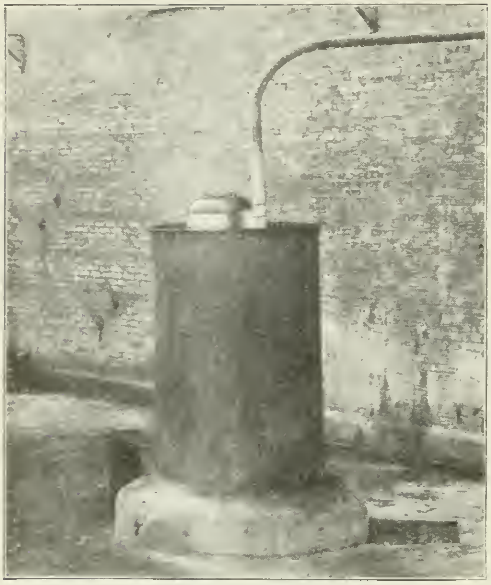


FIG. 4.

The eduction pipe must be filled with air and water, and if it is too large for the amount of water, then a large amount of air must be used to keep up the velocity, the amount of water carried per square inch of eduction area may vary from 15 to 35 gallons, depending upon lift and percentage of submergence. While a 3-inch eduction pipe would be the proper size to carry 100 gallons per minute with a 100-ft. lift and 60% submergence, it would require a 3½-inch pipe to carry the



WELL AT SULZBERGER & SONS.

same amount of water with the same lift under 40% submergence.

This may be readily understood from the fact that the submergence regulates the pressure, the higher the air is compressed the greater its expansive properties, hence the less actual amount of air to do the work and the less room the air will occupy in the eduction pipe owing to its higher velocity. Now with the lower submergence and less pressure and a consequent lower velocity more air must be used, and more space occupied in the eduction pipe by the air on account of the lower velocity.

The eduction pipe should be a smooth tube. In screwing the ordinary pipe together the ends do not butt in the coupling, but a short space is left between the pipe ends; this tends to create a swirl and gives the air an opportunity to slide past the water, which it is always watching for a chance to do.

The air pipe to the well and down in the well carrying the air to the jet should receive due consideration. Every bit of energy used to compress the air to a higher pressure to overcome friction is just so much power wasted, and the extra cost of large air pipes is money well expended, for although the gain may be small it is constant, minute after minute, day after day.

INSTALLATIONS WITH HIGH EFFICIENCY.

We have, we believe, in the foregoing taken up the only real objection that has ever been successfully advanced against the air lift as a system of deep well pumping; that is, the prejudice that exists on the grounds of efficiency. Our contention that this prejudice is unfounded is borne out by recent modern, up-to-date plants that have been installed, such plants as Gottfried Brewing Co., Sulzberger & Sons Co., Jefferson Ice Co., and the plants of the Illinois Vinegar Co., all here in Chicago. In each case the water is lifted more than 200 ft. at a cost that equals the best practice by any other means and in quantities unobtainable under the conditions in any other way. Outside of Chicago such plants as those at the water works of St. Paul, Minn., Joliet, Ill., Fond du Lac, Wis., Plainfield, N. J., Dallas, Texas, and Montgomery, Ala., illustrate what fine results can be obtained with a properly installed air lift under varying conditions of lift and quantity of water produced.

Having disposed of the question of the cost of pumping, let us now see what other points the modern air lift has in its favor, why it should claim your highest consideration.

COST OF INSTALLATION.

The first thing which occurs to most of us is the cost of installation. In this respect the cost of the air lift in small installations, say under 300 gallons per minute, is slightly in excess of that of other competitive methods; from 300 to 800 the cost is about equal, and above this limit the air lift has a decided advantage, even from this point of view. We are considering now, of course, the total cost of plant including the wells. This difference in favor of the air lift being due to the fact that fewer wells are required for an equal amount of water and assurance of continuous operation. The air lift is reliable; it's on the job all day and every day.

MAINTENANCE AND FLEXIBILITY.

Its maintenance cost is in marked contrast to that of the pump which handles the water directly and which of necessity must have its valves and packing continually renewed. The air lift once installed remains put indefinitely. Nothing comes in contact with the water except air and pipe. Its efficiency is maintained and the test conditions are the conditions of operation. The only machinery used is located where most suitable, under the eye of the operating engineer. Any number of wells may

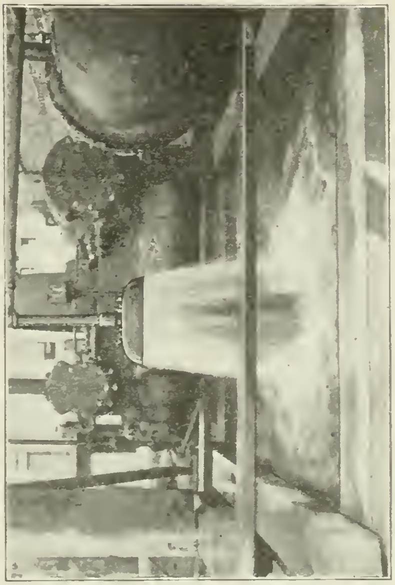
WELL DISCHARGE AT SULZBERGER & SONS.

be operated from the same compressor, provided its capacity is great enough, without regard to the location of the wells themselves. The modern compressor is enclosed, self-oiling, automatic in operation and requires the minimum of attention. When properly designed both the air and driving ends are highly efficient and economical of power.

THE AIR LIFT IMPROVES THE WELL.

With the use of the air lift the well is steadily improved and the flow increased. As far as this pump is concerned sand and solids in the water are no detriment. With the deep well pump of the rotary or reciprocating type foreign matter of this nature must be screened off and in time the well becomes clogged. The air lift draws out the sand and sludge, enlarging the water bearing cavities and so increases the flow.

To summarize: the air lift is above all reliable, inexpensive to maintain, reasonable in first cost, will obtain all the water a well will yield and improve this yield, and lastly, when compared with the true standard total over all cost year in and year out it is equalled by no other system. He who is confronted by the problem of obtaining water from a driven well is indeed fortunate if he can adapt his conditions to an air lift.



WELL DISCHARGE AT KNICKERBOCKER ICE PLANT.

HANDLING MEN AND MATERIALS*

BY W. L. SAUNDERS.

The true way to handle men is to treat them as though they were men and not as servants. A wise manager appreciates and rewards good men and gets rid of bad ones. He is not there to conduct a training school in character or education. He takes men as they are and expects them to do the work that is put before them and to do it well. If they are incompetent and do not, after a reasonable time, improve, he is handicapping his organization by keeping them. If they are immoral, and by this I mean if they do not tell the truth, or if their habits are such that they lose time and work, he must get rid of them, even if it be only for the purpose of creating an example.

Above all things should a manager avoid patronizing his men. Anything that is obtained for nothing is usually not appreciated and is seldom worth having. Working men are usually intelligent beings who expect to receive a fair consideration for their labor. They do not ask for favors and do not appreciate them if they are given to them. A works under the influence of paternalism is not in a condition of permanent prosperity or efficiency. Welfare work is injurious if overdone, but it is very wholesome and proper when done in a practical way. Welfare work really means that it is the duty of employers of labor to provide means of comfort and safety for the men while at work. It pays to have the works clean and to have the best sanitary arrangements, to see that good air and water are available, that safety devices against injury are thoroughly installed, that immediate service is provided for the sick and injured, and that recreation and exercise are encouraged during vacation hours. When welfare work has been misapplied it has extended to giving food to the men free of charge, giving free tickets to entertainments and such-like. Men want a fair wage and with it they prefer to buy their own food and theatre tickets.

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*From address before the Graduate School of Business Administration, Harvard Univei sity, Sept. 26, 1913.

An excellent illustration of practical welfare work is in the Benefit Society, which has been established through so many organizations. In this society the men control the Board of Directors and the Company contributes a sum of money, say, equal to or greater than that contributed by the men. This Benefit Society takes care of the sick and injured and provides a substantial fund to the family of one killed at the works. Here is a spirit of co-operation between the employer and the employed which is far reaching in its effects throughout the organization. Such a system will not be a success unless the employer takes a liberal view of the situation. He must contribute liberally and he must recognize the right of the employes to run the society.

It is advantageous to make stockholders of the workmen. The more the stock of a corporation is distributed among its working force the more surely is the organization to prosper and survive. No stock should be given away, but the whole official family should have an opportunity to subscribe for the stock on a liberal basis, taking plenty of time to pay for it. This system is in use in several concerns that I am connected with, and it has worked beyond our greatest expectations. I have known of cases where good men who quarreled with others in the organization would have thrown up their jobs to the disadvantage of the company but for the fact that they held stock. I have also known a case where waste in the works was brought to the attention of the management by a workman who had one or two shares of stock and who considered himself a part of the organization. To bring a workman to this state of mind is the best possible condition, for it means team work akin to the effect of a foot ball team working toward a common goal.

HANDLING MATERIALS.

In handling materials in a shop it may be said in a general way that railway tracks should be provided only where the material is transported regularly and in volume from one definite point to another. If this is not the case, that is, if the material when partly finished is to be carried to another part of the shop, and so on, then the traveling crane can best serve the purpose of transportation. Traveling cranes for heavy product are of an enormous advantage in making for efficiency. It is a common mistake to economize, especially in foundries, by putting in a few cranes only, where money might be saved by multiplying the number of cranes, even though some of them are idle most of the time. It does not pay to have a gang of men waiting for a crane; it should be there when it is needed. The expense in interest on the investment is negligible compared with the time lost and increased cost of the product that results.

In large floor areas of the saw-tooth construction, or in cases where traveling cranes are not available, the trucking system is used. There has recently been introduced a form of truck which is so simple and which effects such a great saving on the floor that I shall call attention to it. At each machine tool a simple wooden platform is provided, on which the product which is to be carried away is laid. Several of these platforms may be around the same tool. A man goes about the works with a truck, which is so constructed that it is run underneath these wooden platforms and by a simple cam device lifts the platform from the floor and carries it anywhere about the works, depositing it and drawing out the truck for another load. This not only saves the labor of picking material from the floor of the shop and loading it on the truck, but it saves time lost in waiting for a truck to come around

It is always there in the shape of a platform.

Finally, let me call attention to the danger of over-capitalizing a manufacturing business. It is all very well at busy times to spend money on bricks and mortar. Manufacturers recognize the danger of not being able to supply their customers, but times are not always good and at depression periods interest and depreciation eat up profits. It is not difficult for us to think in our minds of large manufacturing concerns that have been brought, some of them, into the condition of receivership, by having shops that are too big an investment; that is, so large that the auditor in making out the balance sheet and figuring the interest and depreciation on the plant finds that instead of a profit there is a loss. There is such a thing as having the shop too big, and in some lines it is best to stop after reaching a certain point of size and to develop elsewhere, thus having two shops instead of one. A works may be too big for a single organization to efficiently handle. A man can do but one thing at a time and do it well. His capacity to look about the floor of the works is limited. If he has too much territory to cover he does not cover it all properly. Competing shops are advantageous in other ways. Managers compete with each other to turn out a better product and at a lower cost. This is the kind of competition, competing within one's own organization; a competition that is not destructive because the control is in the executive force of the company.

Two inventors, each located in different shops, are apt to vie with each other in making improvements in the product. Another consideration is that in time of strikes or other troubles, or in periods of depression, one shop may be closed down entirely and work concentrated upon the other.

WHAT IS "BAD" AIR?

A recent publication of the Smithsonian Institution by Prof. Leonard Hill and several others on "The Influence of the Atmosphere on our Health and Comfort in Confined and Crowded Places," makes some astonishing statements. It is said that the chemical content of the air in crowded places has nothing to do with its ill effects, that, apart from the influence of infecting bacteria, the ventilation problem is one of temperature, of relative humidity and of air movement. The percentage of carbon dioxide in the worst ventilated room does not rise above 0.5 or, at most, 1 per cent., whereas the normal concentration of carbon dioxide in the lungs is from 5 to 6 per cent. of an atmosphere. The writers adduce a great number of experiments and observations to prove that percentages regarded as deleterious or deadly by hygienists are quite harmless. They claim that it is also a fallacy to assume that a diminished amount of oxygen is harmful. At noted health resorts in the Alps the barometer stands at such a height that the concentration of oxygen is far less than in the most ill-ventilated room. One unfortunate result of this fallacy is that the laws regarding ventilation of mines insist on a high percentage of oxygen, and thereby increase the danger of mine explosions. Finally, the widespread belief in the presence of an organic poison in expired air is equally erroneous. The smells of crowded rooms and the like are no indication that the air is deleterious. "The deaths in the Black Hole of Calcutta, the depression, headache, etc., in close rooms, are alike due to heat stagnation; the victims of the Black Hole died of heat-stroke." This is rather more than is likely to be readily accepted.

THE LONG TUNNEL THROUGH SELKIRK RANGE.

Work on the construction of the tunnel through Mt. McDonald, for the Canadian Pacific Railway is now in progress. The tunnel will be a trifle over 5 miles long and will have a 1,700 ft. approach on the west side and a 2,600 ft. approach on the east side. It will lower the grade of the road 545 ft., will shorten the distance by nearly 4 miles; and will practically do away with dangers from snow slides. The portal of the tunnel will be 150 ft. wide by 40 ft., and it will be necessary to excavate 50 ft. before reaching tunnel grade. Before work can be started on the main tunnel the course of the Illesilletewait River for nearly a mile will have to be changed. In doing this the river will be diverted some 900 ft. to the left of its present course. Over 20,000 cu. yds. of concrete will be required for tunnel approaches and the tunnel proper. Foley Bros., Welch & Stewart, St. Paul, Minn., are the contractors. A. C. Dennis, Glacier, B. C., is in charge of the work for them.

USE OF SMALL ANIMALS FOR DETECTING POISONOUS MINE GASES

The following, concerning experiments conducted by George A. Burrell and Frank M. Seibert of the Bureau of Mines, we abstrast from a paper before the Coal Mining Institute of America, Pittsburgh, Dec. 4, 1913.

It has been found in general that the time required for symptoms of carbon monoxide poisoning to appear (or disappear) is proportioned to the respiratory exchange per unit of body weighed. The Bureau has experimented with most of the common small animals, and finds canaries and mice most suitable for the work. They are easily obtainable, and become pets of the men who have them. If handled intelligently they seldom die as a result of their exposure to carbon monoxide.

REPEATED EXPOSURE TO CARBON MONOXIDE.

Canaries, mice and guinea pigs were repeatedly exposed to carbon monoxide under different conditions. In some experiments they were exposed to atmospheres that distress them in about two minutes. In the case of canaries 0.25 per cent. was used in some cases and they were exposed 7 to 10 times, the object being to see if after many exposures they became to any extent acclimatized, and no such effect was noticed.

Animals were also exposed to percentages that quickly distress them, and after removal and recovery they were placed in atmospheres that ordinarily do not apparently affect fresh animals; this experiment was also reversed. It is possible that an animal which collapses at a certain place because of the proportion of carbon monoxide there, might upon recovery be used in an atmosphere containing a proportion that does not usually effect a fresh animal. Again, the same animal might be exposed over several successive days while a mine was being explored. It is believed that the experiments performed show that animals will not become acclimatized to carbon monoxide under the conditions surrounding recovery work in mines, and thus become less useful or even a source of danger. It might be mentioned that this question has been raised several times in discussing the use of small animals for detecting after-damp in mines.

RELATIVE SUSCEPTIBILITY OF DIFFERENT ANIMALS

The Bureau performed many experiments to draw some conclusions regarding the effect on different animals of the same species of a given proportion of carbon monoxide. In general a given proportion affected different animals of the same species in about the same length of time, at least as far as the application of the results to the practical use of the animals in mines is concerned, but that once in a while an animal might behave in a markedly different manner from what is expected. This is truer of mice than of canaries, yet even in the case of the latter several of them should be taken with an exploration party in order to prevent any possible errors.

RELATIVE EFFECTS ON MEN AND ON SMALL ANIMALS.

In reading over accounts of rescue and recovery work in mines, one is impressed with the fact that some users of small animals have not been entirely satisfied with the behavior of mice and birds (especially mice) in that men have apparently felt distress before the animals became affected. The Bureau as the result of many experiments made to determine the resistance of small animals to carbon monoxide poisoning believes it has the data at hand which explain this dissatisfaction.

It was found, for instance, that almost all of the animals tried do not show sufficient distress in one hour's time with 0.10 per cent. of carbon monoxide to make them valuable for detecting this percentage of the gas. In some cases the length of exposure was extended to three hours without any effects being observed. In one case only was a canary affected in so short a time as 12 minutes by 0.10 per cent. of carbon monoxide. With another bird and the same percentage of carbon monoxide, distress was scarcely discernable in three hours. Only a disposition to remain quiet was observed. With 0.15 per cent. carbon monoxide canaries showed distress in 5 to 30 minutes. A mouse showed slight distress at the end of an hour. With 0.20 per cent. canaries responded in from 2 to 5 minutes except in one case (35 minutes). Three mice responded in 12 minutes, and a fourth one in 46 minutes.

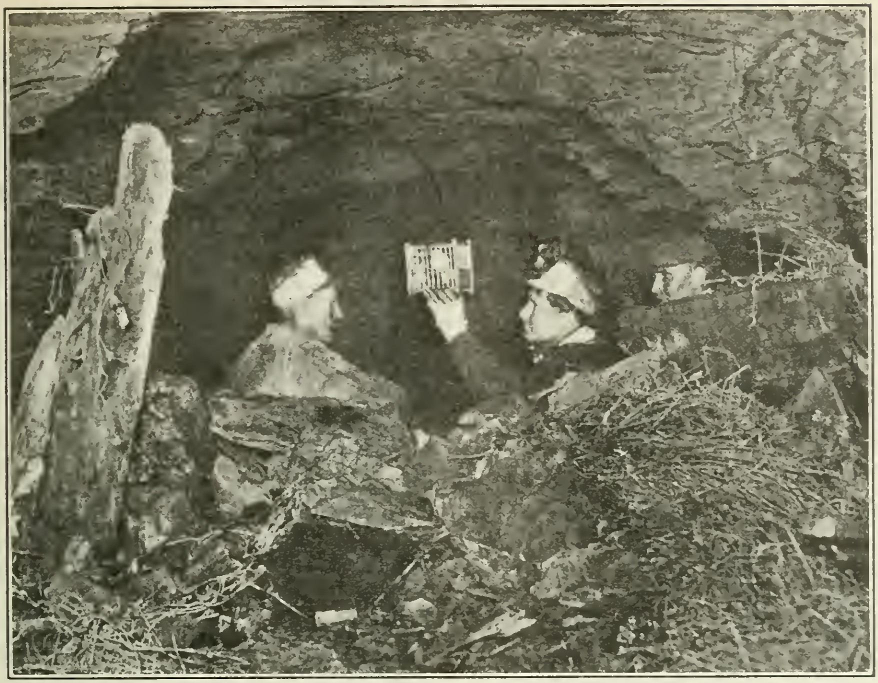


FIG. 1. AN ACTUAL OCCURRENCE IN A MINE DISASTER.

Haldane made many experiments with himself as the subject in determining the effect of carbon monoxide on men. He found that 0.12 per cent. causes a mouse to sprawl in 11 minutes. Haldane felt a slight tendency to palpitation in 33 minutes. In 90 minutes he had distinct dimness of vision and hearing and a slight tendency to stagger, besides abnormal panting when he stopped the experiment long enough to run up and down stairs. In two hours' time vision and hearing became markedly impaired and there was some confusion of mind. When the mouse was finally removed from the cage it could not move about. With 0.045 per cent. of carbon monoxide, Haldane did not notice any symptoms in the four hours that the experiment was carried on, but on running up stairs there was unusual panting, slight palpitation, etc. A mouse was not distinctly affected.

In defining the minimum harmful or poisonous percentage of carbon monoxide, Haldane states that 0.05 per cent. in pure air is just sufficient to produce in time very slight symptoms in man, and the same percentage produces very slight symptoms in mice. He states that 0.20 per cent. is very dangerous to man. With 0.05 per cent. and thereabout, Haldane finds that the gas finally begins to affect man and the outward signs appear in mice.

In connection with the laboratory experiments the author has made observations regarding the use of small animals in mines. One instance is noteworthy, as follows:

A mine fire recently occurred and a sample of mine gas was obtained that contained the following constituents:

	Per cent.
CO_2	1.10
O_2	18.61
CO	0.12
CH_4	0.42
N_2	79.75

This sample was obtained in a place where exploration work was being conducted. Canaries carried with the party were not affected, but two of the men complained of a bad headache. Later when they went to the surface they became ill. One was indisposed all the evening.

These facts, although they appear damaging against the use of small animals for the purpose proposed only militate in part against their usefulness. Such animals still remain, in the author's opinion the best indicators we have of vitiated air in mines. Canaries will give ample warning of percentages of carbon monoxide immediately dangerous to men. Men cannot stand the exposure to collapse from carbon monoxide as animals can. Canaries and mice after distress and collapse recover quickly if exposed to fresh air, only a matter of minutes usually. In the case of men exposed to collapse, recovery is often a matter of days.

When the carbon monoxide content of an atmosphere is raised from 0.10 per cent. to say 0.15 or 0.20 per cent., the susceptibility of a canary or of a mouse to the gas is markedly increased, as judged by the action of the animal, so much more than in the case of men that a canary especially may show distress in five minutes, while a man may require 30 or more minutes. A man, if he exposes himself as long as this, however, may finally become very sick, and, if for longer periods, may become dangerously so.

An Illinois commission found it hard to separate effects on steel workers produced by bad living conditions from those produced on some of the men by carbon monoxide, although they were inclined to the view that carbon monoxide poisoning had considerable to do with the generally poor condition of some of the employees. The exact action of the gas in producing bad nervous disorders still remains somewhat obscure. Some do not believe the action so simple as to merely temporarily deprive the system of oxygen, as in the case of suffocation, although most of the good experimental evidence points to this view. Somewhat analogous is the case of men who work at high altitudes or who suddenly ascend to extreme heights in balloons, where the oxygen tension is very low. Different individuals also may be affected differently at high altitudes. No doubt in cases both of carbon monoxide poisoning and oxygen deprivation by other causes, the idiosyncrasy of the individual plays an important part.

As regards acclimatization to the gas, it has been strikingly shown that guinea pigs may become immune. The compensation found in pigs has also been in part observed in men. The red blood-cells increase to compensate for those put out of action by the carbon monoxide. How long this may continue without pronounced distress on the part of men is a question that requires investigation.

Repeated exposure to carbon monoxide may occur in the case of miners who do the shot firing. Blasting explosions always produce some carbon monoxide in coal mines. Men may return too soon to the working place (before gases have disappeared), to examine their shot, and thus expose themselves to percentages, usually smell of the gas. Where large shots are fired, where the ventilation is poor, and where the working faces are too far ahead of the last breakthrough, contact with harmful percentages of carbon monoxide and other poisonous gases may follow. Miners at some mines frequently go home sick from powder smoke. The general effect on them of such exposure cannot be anything but bad.

In the conduct of exploration work one sometimes hears it said that certain individuals of a party were able to withstand atmospheres that caused distress in other members of the same party. This may be true because some men are more affected than others by the same proportions of the gas, but one or two other causes must be kept in mind. After damp in different parts of a mine, sometimes in two places, quite close together, may differ much in composition, to the extent that at one place a very small and insignificant amount of carbon monoxide might be present, while at another place, close by, a harmful proportion might exist. One person in a party unknowingly might encounter the latter atmosphere while his comrades do not. Another reason usually less apparent to an exploring party has to do with the fact that the amount of carbon monoxide absorbed depends, of course, upon the amount of air breathed. A man at rest may breathe 7 or 8 liters of air per minute. By even moderate exertion this can be increased to 3 or 4 times that quantity. It follows that if one or more members of an exploring party work harder than others they will become poisoned more quickly than the others.

Fig. 1 is a scene at an actual mine disaster volunteers waiting at this point for helmet men to bring the injured out and watching the canary for assurance as to the condition of the air.

Fig. 2 shows two men equipped with Draeger rescue apparatus and one of them carry-

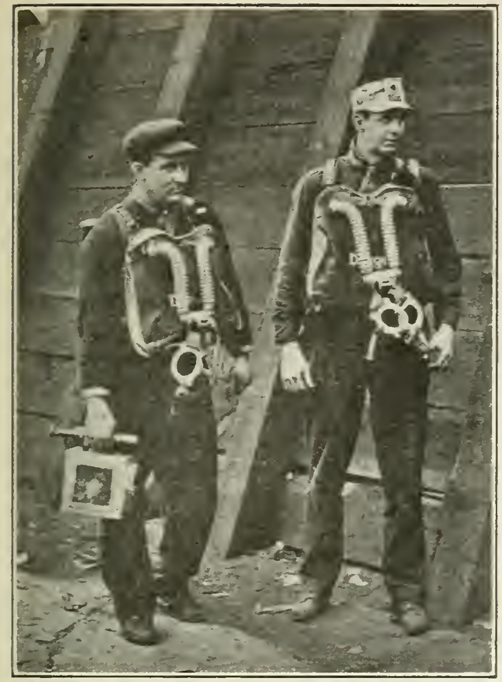


FIG. 2. MINE RESCUERS.

ing a canary. The cage is of special construction, the handle being a container of oxygen. After the bird is asphyxiated it is placed in the cage, the oxygen is released and the bird revives.

CENTRIFUGAL FAN PROBLEMS

BY L. B. LENT.

When the discharge from two or more centrifugal fans is delivered into a common discharge pipe, these fans are said to be running in parallel. The pressure in each case is that which one machine alone would develop, but the air delivered is the sum of the volumes discharged by each fan.

Running the discharge from several fans into a common main or header seems, at first thought, to be a simple matter of connecting the fans up in this manner; but one has but to try it to discover that operation under this arrangement is impossible except under certain conditions. The writer's experience may be typical and serve to point out the essentials of proper operation under the conditions.

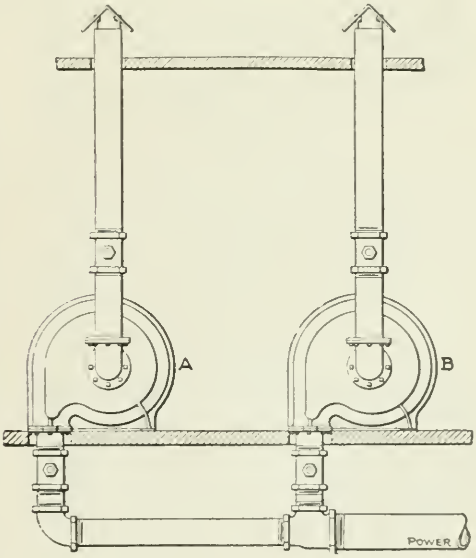
Two large single-stage turbine blowers were connected to a discharge main, as shown in the illustration. When first installed, one fan was sufficient to furnish the necessary air, at about 2 lb. pressure, to serve the oil burners in a number of metal-heating furnaces. The other fan served as a reserve unit and they were run alternately. A rapidly increasing demand for air made it necessary to run both fans together and, eventually, to add a third.

It was only necessary to start the second fan, the first one being already in operation, to discover that it would not deliver any air and that the first fan was actually blowing air right back through it. These two fans were of the same size, direct-connected to similar direct-current motors and ran at the same speed.

An analysis of the action of a centrifugal fan and the flow of air in pipes will show under what conditions centrifugal fans may be operated in parallel. Three facts must be clearly conceived and borne in mind. They are:

1. For a given fan the air pressure generated depends upon the peripheral velocity of the wheel or runner.

2. This pressure can be generated and maintained within the fan casing whether air is being discharged or not by running the fan up to speed with the discharge valve closed.



A FAN PROBLEM.

3. The total head of air in motion is the sum of two separate heads—the static head and the velocity head—the sum being called the dynamic head.

When air is under pressure in a closed vessel, a receiver, for instance, its pressure may be measured by a pressure gage or, if light, by a water column. This pressure existing in the quiescent gas is called the static pressure, and often its static head, being commonly expressed in pounds per square inch, in inches of mercury or inches of water. When air under pressure is flowing in a pipe, the velocity of flow is due to a drop in pressure and is proportional to a certain difference in pressure. The head equivalent to the velocity is commonly called the velocity head, and sometimes kinetic head. The sum of the static and velocity heads is the dynamic head.

When a centrifugal fan is started and brought up to maximum speed, with the discharge pipe entirely closed off the air in the casing is whirled around with the fan blades, and the static pressure measured in the discharge pipe is that due to the linear speed of the blades. With no air being delivered the fan will absorb only a small amount of power. It is only when air is actually discharged against a resistance that more power is absorbed by the fan. When air is rushing in a pipe the velocity with which it is rushing is equivalent to a certain pressure, and the velocity head is easily and accurately measured in units of pressure by means of the pitot tube.

An examination of air tables, referring to fan work will show that the velocity component is a considerable part of the total pressure. It is the velocity head, due to the inertia of the moving air, which must be dealt with when running fans in parallel.

Referring to the illustration, when fan *B* was running and delivering air at a static pressure of 2 lb., fan *A* was started and brought up to the same static pressure as fan *B*, but not a cubic foot of air did it deliver. On the contrary, air was actually flowing out of the intake pipe of fan *A*. The reason was, that the air being delivered from *B* was flowing at some velocity instead of being at rest and, consequently, had a velocity head in addition to a static head of 2 lb. If the velocity head be assumed at ½ lb., then the total or dynamic head of the discharge from *B* is 2½ lb. Since no air is really flowing from *A*, even though the wheel be running at a speed sufficient to generate a static pressure of 2 lb., the total head (static and velocity) at the fitting below *B* is greater than the total head (static only) existing at the outlet valve of *A*. As soon as the outlet valve of *A* is opened, the greater pressure will actually force air back through fan *A*. To make *A* deliver air, it is necessary to throttle the discharge from *B* until the dynamic head at *B* decreases to an amount equal to or slightly less than at *A*.

Some form of measuring instrument must be used to indicate the discharge from each fan, so that it may be positively known that each fan is delivering its proportion of the amount of air flowing. A simple instrument for such use is the pitot tube, arranged as a differential gage, and so indicating velocity only. There will always be a flow if a velocity is indicated, and if pipe sizes are proportional to the volumes flowing, the velocities from each fan should be equal. If, therefore, the readings from the pitot tubes from the discharge sides of two or more fans are the same, it is quite certain that these fans are delivering their proportional amounts of air.

When fans of different sizes and speeds are connected to deliver air to the same main, the problem of their parallel operation becomes more complex, but is based on the same equality of total or dynamic heads.

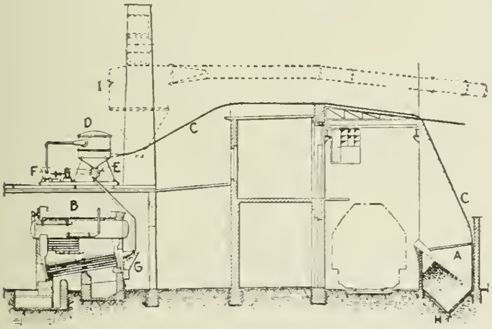
Starting up an idle fan and putting it into the line is, of course, the troublesome part, for, until air is actually flowing through and away from the fan, it has no velocity head. If it can be speeded up so that its static head alone is equal to the static and velocity heads of the fans already in operation, then the higher static pressure will start the air flow, and the speed must then be adjusted until the dynamic head is the same as that under which the other fans are running.

When the speed of the fan cannot be raised above that of the running fans, which is the more common condition of operation, then the dynamic head of the running fans must be reduced to equal that of the static head of the fan being put onto the line.

This operation, when there is more than one fan already running, is not an easy performance. Paralleling two fans is easy, but paralleling three is not. The usual type of inlet and discharge valve furnished by the makers is some form of butterfly valve or slide gate, and a fine adjustment of the former is a work of art. A pitot tube on the discharge side of each fan with the gages so connected that the operator may read all from one point seems to be the most desirable arrangement, when it is necessary to parallel fans.

The usual method is to adjust inlet or discharge valves, and it is sometimes necessary to move fast from one fan to another, to get the fans together and to keep them together after they are in.

When positive blowers or compressors are discharging into the same line, the conditions are quite different and, up to the limit of the possible discharge pressures developed, each machine will discharge its proportionate share of the air.—*Power.*



PNEUMATIC TRANSPORTATION OF COAL.

The cut herewith, taken from *Gluckauf,* shows an arrangement for the pneumatic transportation of coal as in operation at the establishment of Simon, Buhler & Baumann, Frankfort-on-the-Main.

The coal shed *A* is at some distance from the boiler house *B*. The transportation of the nut coal in hand trucks or barrows across the shipping track was inconvenient, owing chiefly to blockage of the way by freight cars. The pneumatic system avoids this difficulty. A pipe *C* was run from the coal shed over the railroad track and storage building directly to the place of use. Above the boiler house is the vacuum receiver *D* with discharging device *E* and an electrically driven air pump *F,* so that the coal is brought directly into the hopper *G* in front of the automatic stoker. By means of the motor starter, the fireman in the boiler house can start or stop the transportation. Since the coal is bulky, the suction mouthpiece *H* in the shed cannot automatically suck it up as in the case of grain and other granular material, but a special arrangement must be employed which enables a completely automatic service. In the transportation tube the coal moves with considerable velocity, and when passing curves, rubs on the tube walls. Curves are, therefore, to be avoided so far as possible, and where indispensable they should be gentle ones. Discharge tube and chute must be as short as possible.

The coal collecting in the vacuum receiver *D* sinks through a steep funnel bottom to the discharging device *E*, which cuts it off from the vacuum. It consists of a cell wheel turning at about 10 r.p.m., and emptying the coal in small quantities. The coal dust forming in the receiver is caught on screens and by shaking with a hand lever the coal is resized.

For large plants a wet filter is recommended, that is, a reservoir filled with water to a certain height. The air containing coal dust is sucked through and thus cleaned. The slime thus produced is drawn off into certain chambers, dried and briquetted.

The furnace can also be fed automatically by a chip or sawdust-conveying plant *I* of about the same power. The movement of the air is produced in the plant described by a rotary blower *F*, belted to a 6-hp. electric motor. The quantity of coal conveyed is about 6½ cu. yd. per hour.

The joint commission of the States of New York and New Jersey, which was primarily created to devise plans for bridging the Hudson, has been brought seriously to consider the alternative of tunnels under the river as highways for general traffic and travel by ordinary vehicles. This looks as if bridges over the Hudson, although talked of for many years, may never materialize. The satisfactory experience already had with passenger tunnels should go a long way toward creating confidence in vehicular tunnels. But perhaps the most conclusive argument will be the fact that while the estimated cost of a bridge at 59th Street is $42,000,000, two tunnels, one for movement in each direction, could be constructed under the river from about Canal Street, where it would be of the most use, for not over $11,000,000.

MITCHELL DUST CATCHER FOR STOPE DRILLS

BY CLAUDE T. RICE.

The success which has attended the use of the air-hammer stope drill in all kinds of rock has, one might almost say, revolutionized drilling practice in this country. Now, far the greater part of the ore broken underground, in the United States at least, is broken with air-hammer drills of the so-called stope type which are used alone successfully in the drilling of dry holes, although recently the plugger type has been improved so that, under certain conditions, that type of hammer drill can be used with marked success for the drilling of water holes. With this great increase in the number of dry holes that are drilled is sure to come increased trouble due to miner's consumption unless something is done to prevent contamination of the mine air by the dust from the drilling.

There is an important difference between the drillings coming from a hole put in by a piston machine and those from one put in by an air-hammer drill. The piston drill hits a harder, slower blow, and therefore tends to chip the rock more than does the air-hammer drill. On the other hand the air-hammer drill hits a much more speedy and quicker, but lighter blow, than the piston drill, and tends more to mash the rock than cut it, so that, of necessity, the drillings coming out must be finer, and therefore more apt to float around for a considerable time in the air, than the heavier drillings. But in either case the air is badly polluted when an upper is being drilled in dry ore with either type of machine, unless some means of preventing dust pollution is provided. This fact that more dry holes are being used in breaking the ore, and that these dry holes are being put in with the type of drill that makes the most dangerous kind of dust, must in the end cause a decided increase in the amount of miner's consumption.

Three methods have been tried in preventing the rock drillings from contaminating the air of the workings. The first has been to squirt water into the hole as near its bottom as possible so as to wet the dust down before it gets out of the hole. The second method has been to dampen the dust just as it comes out of the hole either by a spray, or else by a wet sponge against which it has to impinge, thus cleaning the air by a sort of scrubbing action. The third method has been to let the dust form and catch it in some trap or receptacle before it gets out into the air.

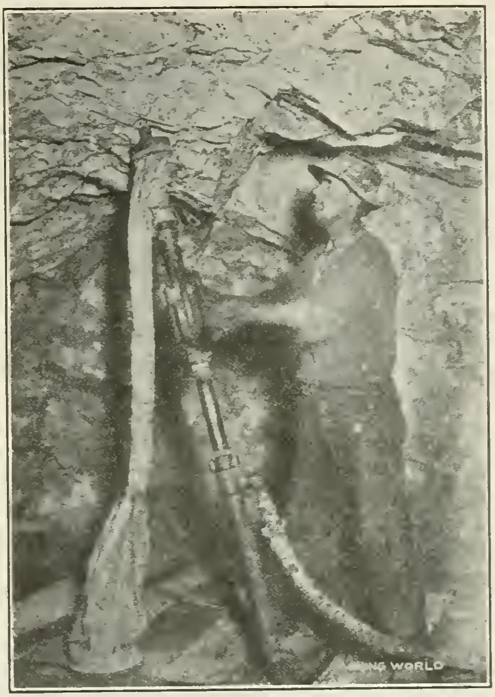
Probably the best way to allay the dust is by squirting the water right into the bottom of the hole through a hollow drill steel as is done in the water Leyner drill. When the water is squirted in along the sides of the hole there is a tendency for a collar of mud to form just beyond the range of the spray, and this interferes considerably with the discharge of the drillings. The objection to the use of a spray is that the miners get wet, and that, to a large extent, is the objection to all water methods of dealing with the dust from an "upper." The miners get wet, and then they have rheumatism. With the rheumatism a present evil, and the menace of miner's consumption a more distant danger, most of the miners oppose strenuously such methods of fighting the dust, and abandon the use of such apparatus as soon as they can. Where the water is squirted clear to the bottom of the hole the objection is not nearly so great as when the water is squirted into the hole with a tube that generally is kept at least a foot or so from its bottom, while the spray method is the one that is condemned the most of all.

The only way to avoid the use of water is to catch the dust. Recently, a dust-catcher for use with air-hammer stopers has been devised that is practical and successful. This dust catcher is the one devised by Thomas E. Mitchell, one of the mine superintendents at Butte, and is used with success at the Leonard mine, where it was worked out as to the details of its construction. Not only is it simple and practical, but it is also cheap and serviceable. Several other different types were tried before this was devised; several of them on the spray idea. But this is the only one that the miners have shown any liking for. The device has been in use upwards of a year now. In the stopes as well as elsewhere, indeed, the raise men will not work without it. There is no trouble in changing drills, nor is the dust catcher unhandy to set up at the hole. It is absolutely free from leakage, and so, as the dust can not work back along the drill steel, this dust catcher also has the considerable further advantage that it keeps the drillings out of the moving parts of the machine as well as out of the air of the mine workings.

As the accompanying illustration shows, the Mitchell dust catcher is a canvas bag that envelopes the drill steel. Putting off from the main body of the dust catcher is a smaller tube that discharges the dust into a bag. This bag is tied around the bottom of the discharge tube, either by draw strings sewed into the bag or else by an ordinary string. To keep the discharge tube from collapsing, it has some rings sewed into it to help hold it open, while longitudinal ribs are also used for this purpose. The only place that dust could possibly get out into the air would be right at the collar of the hole. But as the collar ring of the dust catcher can be made to set close up to the ground there is no trouble arising on that score. Leakage around the drill steel at the other end of the main tube is prevented by the seal that is provided to make just that occurrence impossible. The wear and tear on the contrivance, as can be seen, is not great, and the main deterioration would be through rotting of the fibre of the cloth by acid in the ore.

Rivetted to the iron ring of the collar of the dust catcher, which is hemmed into the cloth, are prongs of spring steel that go into the hole and grip the dust catcher to the ground. These prongs or horns are made to enter a hole as small as 2 ins. in diameter, yet they will grip the ring tightly in place in a hole as large as 3 ins. across. The hole has to be drilled to a depth of about 6 ins. before it is advisable to put the dust catcher on, although it can be used when the hole is somewhat shallower. The drill steel is then inserted into the body tube of the dust catcher and the bottom end secured tightly to the drill steel, the drill steel having in the meantime been inserted in the chuck of the hammer drill, and the air turned into the feed tube of the drill so as to hold the machine up there while the dust catcher is being adjusted.

The secret of the success of this device is in the method of sealing this joint between the bag and the drill steel, no matter what the type of steel used. The speed with which the bag can be fastened at its lower end is due to the fact that the ends of the cords which are used in doing the typing are gripped in triangular clips, such as are used on the suspenders of bib overalls. So the cords only have to be pulled down into the contracted part of the clips to fasten them securely from slipping. To loosen the tie on the dust catcher, so as to allow the drill steel to be taken out, all that is necessary to do is to give the ends of the cords a couple of jerks so as to get them out into the big part of the clips; then the drill steel is freed. Were it not that a special lining is provided at the lower end of the dust catcher's body, the seal obtained would not be dustproof. But as in the Mitchell dust catcher a lining of sheepskin tanned with the fleece on is used at the bottom of the body tube with the wool turned toward the drill steel, the tightening of the cords at the bottom forces the wool to conform closely with the shape of the particular steel that is then being used in the hole, and thus any leakage of dust is prevented. Owing to the resilience of the wool there is no noticeable deterioration in the seal that is obtained even after the dust catcher has been used for a year or more. Indeed, it is upon this happy thought of using a piece of fleece to make the seal that the success of the Mitchell dust catcher depends. This use of the fleece as a seal on dust catchers has therefore been patented.



THE MITCHELL DUST CATCHER.

The drill steel is gripped tightly enough by the fleece so that the dust catcher follows up with the steel as it goes farther into the hole, until finally the canvas of the body tube is all bunched up around the collar of the hole. Then the drill steel feeds on through the fleece-sealed joint until the steel has been run clear out.

The air is then turned off from both the operating and the air feed cylinders, and the machine taken down. The drill steel can then be removed from the hole, the dust catcher being left hanging by the prongs from the collar of the hole. A new drill steel is inserted, the hammer drill put up into place, and the air turned on to the feed cylinder. Finally the cords for making the seal are pulled taut and clasped in the gripping clamps, and again everything is ready for drilling. Thus no matter whether a hexagonal drill follows a round drill, or a cruciform steel follows a drill or round section, a tight joint is obtained. Moreover, the change from one drill steel to another is easily and quickly made; even more easily than it would seem in a description of the different steps. Indeed, it does not take much longer to make the change with a dust catcher being used than when one is not used.

A CAREFULLY PLANNED AIR PIPE LINE

The half-tones, here reproduced from Engineering and Mining Journal, show the elaborate and somewhat unusual arrangements employed by the Witherbee-Sherman Company, at Mineville, N. Y., for installing the pipe line which conducts compressed air from the central air-generating station to the various mine entrances. The line has been built in two sections, the first being of 12-in. pipe and extending from the compressor house to the Joker power house, about 1300 ft. In this case the pipe was supported on bents made up chiefly of pipe, the pipe of the cap serving as a roller. The air pipe merely rested on the cap. As a result of bulging, set up by the linear expansion and contraction of the line, side motion on the bents resulted, and the line required watching to prevent the pipe from falling off the bents.

Increases in operations at Barton Hill necessitated an extension of the line to that point. The company, as the result of a property purchase, had come into possession of a large quantity of 7-in. and 8-in. pipe and the desirability of using this determined the diameter of the pipe in the extension rather than any calculations of volume, velocity and friction loss. The line is 4300 ft. long, 1000 ft. of this length being of 7-in. pipe. Concrete bents were used in general, spaced 20 ft., but in certain cases where greater height was desired to cross roads or because of topographic conditions and also because the waiting for the concrete to set introduced awkward delays at times, wooden bents were substituted. A series of such wooden bents on one side of a road is shown in Fig. 3.

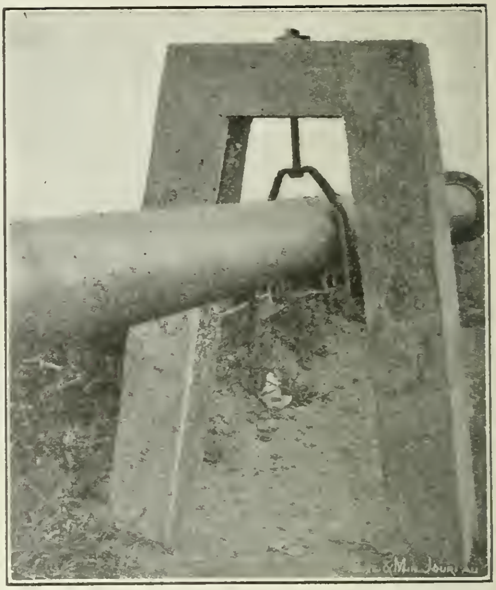


FIG. 1.

The concrete bents, of which one is well shown in Fig. 1, were cast in place; there is a concrete sill or foundation in the ground to complete the bent. Reinforcement is obtained with two pieces of old 1⅛-in. cable, each piece forming a complete loop through the cap, legs and foundation sill, the ends overlapping in the sill. The average height of the concrete bents is about 4 ft. 10 in. To maintain grade for the pipe, bents of varying height were, of course, necessary. This was provided for by lengthening the legs of the forms. The legs and cap are about 8x8 in. in section, the sill is somewhat larger. The cap is 27 in. across the top. A vertical hole through the center of the cap permits the insertion of a ⅞x16-in. bolt with a rectangular ½x3x4-in. washer to bear on the concrete. From this bolt hangs the bridle shown, made of ½x2-in. material. A ⅞x12-in. machine bolt forming the bottom of the hanger, provides a bearing for the iron roller, on which the pipe rests. This roller has a concave surface, the concavity having a slightly greater radius than the pipe. It is 6 in. long, including one 1-in. projection on each end, which gives additional bearing. The center portion is about 2 in. in diameter. The wood bents are also of 8x8 in. section.

The rollers permit of so easy a motion along the pipe line that provisions to take care of expansion need be inserted only at infrequent intervals. The ells at the corners, such as that shown in Fig. 2, serve this purpose and there are several of these, inasmuch as the line follows a rather tortuous course. In the longer straight stretches, and where necessary, slip joints are inserted and anchoring provided to control the pipe motion.

Concrete is extensively used by the Witherbee-Sherman Company, since the tailing piles furnish excellent sand and aggregate up to 2-in. in size. The substantial design of the entire installation is the result of a desire to keep maintenance charges at zero, an attempt that has been successful so far. The pipe and the wood bents are all well painted.

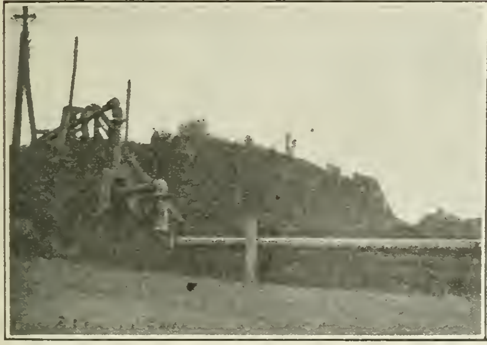


FIG. 2.

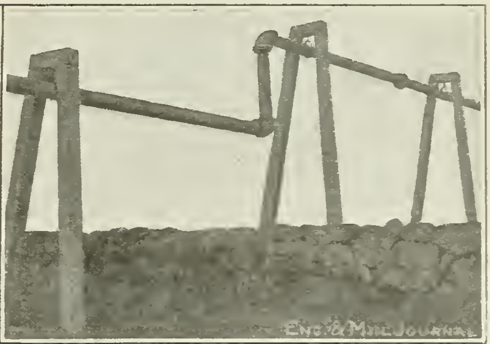


FIG. 3.

RELATIVE COST OF HAND, STEAM AND AIR-DRILL WORK IN CITY TRENCHES

The unit costs of drilling ledge and boulders in trench-work for sewers, water pipes, etc., and other construction work in city streets have always been high, because it is seldom economical to install a steam-power plant and piping for such small jobs, and drilling by hand in a large city where wages for labor are high is necessarily expensive. The advent of a portable air compressor (operated by electricity or gasoline engine) not too heavy to be moved easily from street to street has seemed to solve the problem of accomplishing this class of work economically. the cost per cu.yd. of rock excavation about

Based on hand-drilling costs, a standard rate of $4 per cu. yd. has been allowed for rock removed within trench limits on water-main installation work in Boston, Mass. The amount allowed in solid rock per running foot in ordinary trenches for water pipe is 15 cu. ft. Actual costs of this Boston city work, sent us by Frederick I. Winslow, an engineer in the Sewer and Water Division of the Public Works Department, are as follows:

With a hand-drill the number of feet drilled in a working day of 8 hr. varies from 8 to 12 ft., the cost per day of the drill gang is $7, the cost per lin.ft. drilled about 87c., and $3.50. A steam-operated drill is capable of 50 to 70 ft. per 8-hr. day, the cost of operation $12 per day, the cost per lin.ft. about 24c., and the cost per cu.yd. of rock excavation about 96c. A compressed-air drill is able to drill from 80 to 120 ft. per day, and the cost of operation, including an allowance for depreciation, repairs, moving, etc., is $16 per day, the cost per lin.ft. about 20c., and the cost per cu.yd. of rock excavation about 80c. The difference in favor of the compressed-air drill is greater than the figures show, according to Mr. Winslow, on account of the greater ease of manipulation, and the fact that the compressor can be operated by unskilled labor.

The above costs for steam and compressed-air drills are based on but one drill operated from the power plant, although, of course, either type of plant is capable of operating other drills; with the small portable air compressor used two drills may easily be operated simultaneously.

DUNN PULVERIZED COAL BURNER

BY G. A. ROUSCH.

One of the most important improvements in the manufacture of Portland cement is the introduction of the powdered coal burner. Probably the best known installation for metallurgical work is at the plant of the Canadian Copper Company, Copper Cliff, Ont., where 50 tons of pulverized coal per day is burned in the reverberatory melting furnaces. It has been decided also to put powdered coal burners in the furnaces of the Anaconda Copper Company, at Anaconda, Mont.

The principle of the burner is to feed, by a screw or some other device, a continuous stream of powdered coal into a blast of air issuing from a nozzle at high velocity, and then to convey this to the furnace where the coal dust is ignited by the heat radiated to it from the walls of the furnace. The main difficulties encountered are the securing of a perfectly uniform feed of coal dust, and getting it evenly distributed and suspended in the blast of air. A form of burner which has practically entirely overcome these difficulties has been developed by Mr. William R. Dunn, Superintendent of the Vulcanite Portland Cement Company, Vulcanite, N. J.

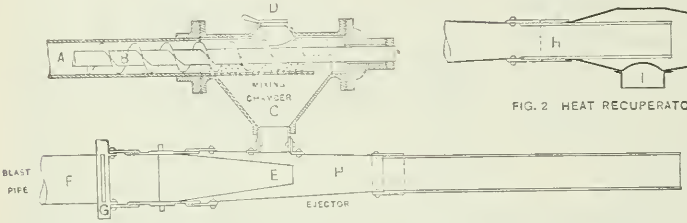


FIG. 1 PULVERIZED COAL FEEDER

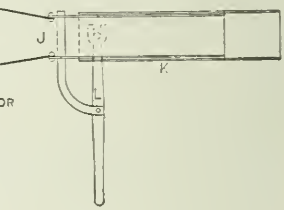


FIG. 2 HEAT RECUPERATOR

The construction of this burner is shown in Fig. 1. *A* is the feed pipe to the storage bin; *B*, the feed screw; *C*, the mixing chamber; *D*, an air valve; *E*, the air nozzle from the blast pipe *F*, the supply of air from which can be regulated by the gate valve *G; H* is the ejector to carry the mixed coal dust and air to the furnace. The important point in the construction of the burner is that, instead of allowing the coal to drop to the air nozzle just as it is fed by the screw, with more or less irregularity due to a slight amount of adhesion of the coal particles, the coal is carried along by the screw and gradually fed out through the perforations in the feed plate, the size of the perforations and the speed of the screw being so regulated that the coal just reaches the end of the perforated plate, for the maximum capacity of the feeder. This method of feeding completely does away with irregularities in the coal supply, and at the same time gives a more uniform suspension of the coal dust by drawing in a portion of the air through the valve *D* by the injector action of the air jet at *E*, the air thus drawn in mixing with the coal in the chamber *C*, instead of depending, for the entire distribution of the coal dust, on the action of the air jet from *E*. This uniformity of feed and suspension makes it possible to regulate the air supply very closely, so that only a small amount of excess air will be required by the combustion, and entirely does away with the "backflashes" that result from lack of uniform mixing of the air and coal. By regulating the valves *D* and *G*, the proportion of the total amount of air required that is mixed with the coal in *C* can be controlled, as demanded by the composition of coal, and other conditions of combustion.

As applied to the cement kiln, the burner is supplied with the "heat recuperator" shown in Fig. 2. Only about two-thirds of the air required for the combustion is supplied at *D* and *G*, the remainder being drawn in through *I* by the injector action of the blast of air issuing from the ejector *H*. From *I* a pipe leads to the pit under the kiln into which the hot clinker is discharged, so that the air drawn in is slightly preheated. This of course amounts only to a small saving, but since the cost is no more, it is worth while.

The length of the pipe leading into the kiln can be regulated by the sliding sleeve *K* and the lever *L*. The distance from the kiln wall to the end of the pipe has considerable influence on the shape of the flame.

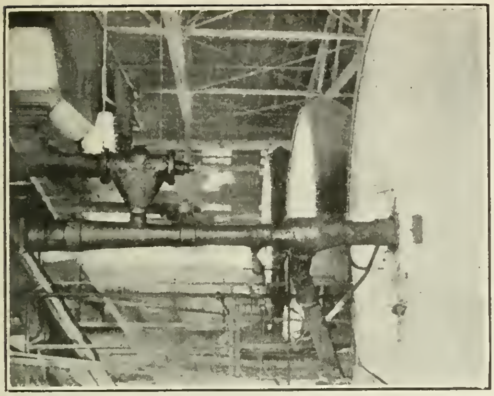


FIG. 3.

Fig. 3 shows an installation of these burners in the Vulcanite plant, burning 2600 lb. of coal per hour, in kilns 125 ft. long, 7 ft. inside diameter and 8 ft. 6 in. outside diameter, using an air pressure of 8 oz. and a coal, 94 per cent. of which passed a 100-mesh sieve. Sixty-foot kilns just beyond these were burning 800 lb. per hour. The flame was about 20 ft. long and the coal ignited at only 4-6 in. from the end of the ejector pipe of the burner. The stack gases left the kiln at 500-550 deg. C. The condition of the end wall of the kiln speaks for itself in regard to the absence of "back-flashes"; these always smut and blacken the wall, but this wall had not been whitewashed for over 30 months.

The substitution of these burners for oil burners in these kilns resulted in a saving of approximately 75 per cent. of the fuel cost in calcining, and at the same time, the capacity of the kiln was increased by some 25 per cent.

These burners are working satisfactorily in units as small as 50 and 75 lb. per hour, and it is thought that these smaller sizes can be successfully applied to steam boilers, with a considerable saving of fuel.—*Metallurgical and Chemical Engineering.*

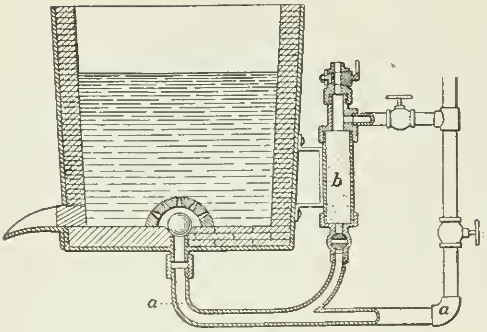
Condemned as useless only a few years ago, Eiffel Tower, the highest structure in the world, is now regarded as one of the most valuable of the possessions of France. It has made Paris the center of the wireless world. There would seem to be now good reason and strong incentive for the United States to build a tower much higher.

COMPRESSED AIR AT COST FOR MINE LESSEES

The mines of the Wolf Tongue Mining Company, in the Nederland tungsten field of Boulder county, Colorado, are operated under a leasing system, the company furnishing the equipment. To encourage the opening of the deeper ore bodies the company bears part of the expense of such development, paying the lessees $7 a foot for sinking. The company has just installed two electric driven two stage air compressors, 14x7½x10, and has laid pipe to the eleven mines on or near what is known as the Trevarthen ranch. The compressors can be operated either singly or together. The company will furnish the drills, charging no rental but the upkeep. For the air and sharpening the steel, it will charge at first a flat rate of $2 a day. As more lessees use the air, this rate will be lowered, and it is believed that for 10 drills it can be brought down to $1.25 a day. The purpose is to furnish the air at cost. All that the company expects to gain is an increased production. For the lessees it means a greater efficiency and larger profits.

MUNICIPAL AIR DRILL EQUIPMENT

The superintendent of sewers of Worcester, Mass., Matthew Gault, aims to keep at high efficiency the equipment used by the department. In 1912 a new blacksmith shop was built and supplied with modern equipment, and a complete new outfit was purchased for rock excavation. The forges are supplied with power blast. A 100-pound Fairbanks power hammer has proved very useful, as has also a Leyner drill sharpener which has a capacity of from 50 to 100 rock drills per hour. It is operated by compressed air furnished by a 9x8-inch Ingersoll-Rand compressor, which in turn is operated by a 20 horse-power electric motor. For rock work, especially in trenches, an 8x8-inch Ingersoll-Rand air compressor, geared to a 15 horse-power gasoline engine, both mounted upon trucks, has been purchased. They furnish sufficient power to operate two hand hammer drills using hexagonal hollow steel. The plant is portable and can be moved easily from place to place, and Mr. Gault says: "We are conservative when we say that for our work in narrow trenches this outfit has reduced by one-half the cost of drilling, as compared with the cost of steam drilling."—*Municipal Journal.*



DE-SULPHURIZING MOLTEN IRON WITH COMPRESSED AIR

The cut herewith shows the essential features of a process for removing sulphur from molten cast iron recently patented by W. F. Prince, foundry superintendent, Henry R. Worthington Company, Harrison, N. J. Ordinary compressed air is admitted through the pipe *a* into the bottom of the ladle. The cylinder *b* is used for holding the powdered alloys that it may be desired to inject into the metal with the air. The entire mechanism is attached to the ladle so that the reaction can take place as soon as the metal strikes the ladle and while it is being transported some distance to the moulds. The reaction which it is claimed takes place as the "air, gas or steam or other equivalent" comes into contact with the molten metal is that it oxidizes the manganese, creating manganese oxide, which, owing to its affinity, unites with the sulphur to produce a slag which rises to the top of the ladle or reservoir, where it may be skimmed off. During this operation a small quantity of the manganese unites chemically with the sulphur to form manganese sulphide, which rises to the top after it is formed by the agitation produced by the oxidizing agent.

CARE OF PNEUMATIC DRILLS

BY H. J. KIMMAN.

After running his locomotive from 100 to 150 miles a trained engineer climbs down from his cab and proceeds to count all the wheels to begin with. He feels all the rod connections and sees that they have oil, and if he has heard any untoward noise or clatter during his little trip he burns up the telegraph to tell his chief about it.

Now, the locomotive has not done so much of a stunt after all. It has only made about 30,000 turns, allowing for some slip, and, by the way, if the engineer slips it too much he gets a layoff. Now, a pneumatic drill is some machine when compared with this ponderous locomotive, to which some of the most eminent engineers in the world devote so much time and thought. A pneumatic drill in the hands of the most inexperienced help will, when used on reaming holes in this big locomotive's boiler make to exceed 1,000,000 turns in a day of ten hours, and no one to count the wheels. If a locomotive made a million turns it would have run 3,300 miles and spent about two weeks on the job, and half the time in the round house. The pneumatic drill is an engine, as fine an engine as any other type. Why not give it a little of the care which railroads are expected to give their engines? We believe it would repay you in service.

The price of your product, Mr. Manufacturer, to some extent depends on the endurance of ours. Why not strive by timely care and watchfullness to increase the life of ours and so cheapen yours. You may think that you give these drills the best of attention, but do you? The writer himself has seen many varities of the care that is bestowed on pneumatic drills. He has in mind a large shop, a sheet iron soft coal burning stove, both doors open and a nice big dirty fire inside immediately adjoining a rack on which drills are kept, the ashes from the stove covering the drills.

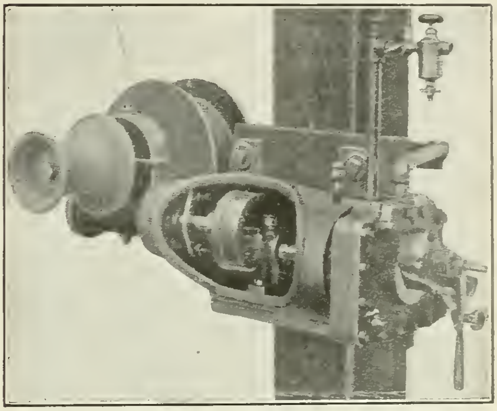
And now a word about grease. How long would a locomotive run if at uncertain intervals, averaging once a week, it was treated to a mess of grease of the consistency of putty (and just about as efficient as a lubricant). Grease with a fancy name and no lubricating value in proportion to its mass—grease which a shipbuilder would hesitate to smear his ways with for fear the ship would stick, and this little engine is expected to digest it or go without. We are not so old but what we can remember when a locomotive had a tallow cup and every time the engine stopped, the engineer would give it a dose of tallow, and it was nothing unusual for a shop machinist to find cylinder and especially valve seats honey-combed by the action of this tallow, and then it was chip and file to make a new valve face.

Now why expect of this little engine the things your big one could not do? An Eskimo thrives on tallow, a locomotive dies on it, and a pneumatic drill resembles a locomotive, not an Eskimo. It has a delicate appetite. It requires the best of heavy oil applied at frequent intervals, quite unlike the Eskimo who, when he eats, eats all at once and then perhaps not again for a week. Now, if you want the best work from pneumatic drills treat them right—give them the things they like. There may be cases when it pays to ruin a good machine to accomplish the work demanded of it; however, these are rare.

We have read of instances where riders have run a good horse to death, but accomplished the end aimed at. Under these conditions you do not blame the horse, while you praise the rider. You do not condemn a match after lighting has served its purpose. You are satisfied to throw away the stub. Now, when you work the little drilling engine as the horse or the match, that is to say, work it to death, why blame the machine if it has served your purpose as the match has. You have burned them both up, why not be consistent and when you say that this was a good match, also say "it was a good drill."—*Ideal Power.*

MOTOR SPIRIT FROM WASTE OIL

A process for the conversion of waste oil into motor spirit, and by which, according to Professor C. Vernon Boys, F. R. S., 43 per cent. of the original oil can be obtained; has been acquired by the British Motor Spirit Syndicate, Limited. The method consists of converting water into steam, which, at a temperature of 600 degs. Fahr., is brought into contact with the heavy oil to be treated, which has also been heated to a certain temperature. The steam and oil flow together through a series of heated tubes, in each of which there is a nickel rod. The steam, oil and nickel, when they meet, set up chemical action which drives the hydrogen from the steam into adhesion with the oil, so that the latter, which before treatment had an excess of carbon, has now an excess of hydrogen. This excess is sufficient to transform the heavy oil into a light oil or spirit. The gas can be used for providing heat for the retorts, while, on the other hand, the heavier oils are available for retreatment. The lighter oils make an admirable motor spirit. The process has been subjected to a test made by the Daimler Company, as a result of which Professor Boys states that the spirit is at least equal to petrol (gasoline) when used in a motor car.—*The Engineer, London.*



THE NEVADA WINZE HOIST

The half tone shows a power windlas for light hoisting, especially in mining work either underground or at the surface. It can be operated either by steam or air, the latter being of course the more prompt and ready in action without delay in heating up or to get rid of the water of condensation. It may be bolted to a post as shown or to a stull wedged in at any convenient place.

The drum is 11 in. diameter, 6½ in. between flanges, taking 5-16 or ⅜ in. wire rope. On the end of the shaft is a turned gypsey head to handle a fall—½ in. to 1 in. diameter. The shaft is driven by worm gearing with ball bearing thrust.

The motor is of the square piston type, developing 3 horse power with 80 lb. pressure. The control is by a single lever for stopping, starting or reversing, with accurate and delicate regulation of speed. A load of 450 lb. can be raised at a speed of 70 ft. per min. Materials, workmanship and lubrication details are all up to date. The hoist is built by the Nevada Engineering Works, Reno, Nevada.

German authorities are stating that in the commercial production of liquid air 1 h. p. hr. produces from 3 to 8.5 cu. in., according to the apparatus and arrangements employed.

COAL MINING WITHIN THE ARCTIC CIRCLE

At Tromso, Norway, 750 miles from the North Pole, there is a coal mine in constant and successful operation, although not upon a very extensive scale. The product goes to northern Norway and to Russia, and as the season of navigation lasts only four months there are two clamshell buckets, a Brown hoist and a Hayward, constantly employed either in accumulating piles of coal or in loading it on the ships.

The longest entry of the Arctic Coal Company's workings is over 2,300 feet. and although the miners are working at the face about 1,000 feet vertically below the surface they have not reached a depth to which the ice and frost has not penetrated. The highest rock temperature recorded in summer or winter is twenty-seven degrees Fahrenheit. At this mine the miners have never seen a drop of water or a trace of gas underground.

There are about 300 men employed at this mine throughout the year, and they are entirely cut off from the outside world during the winter months. In order to keep in touch with civilization, the company has installed a wireless telegraph station which receives weekly reports.

Besides the Brownhoist and Hayward clamshell buckets, this mine is equipped with a complete electric power station, and the camp and mine are lighted by electricity. The mine is being worked by the advancing long-wall method used electrically driven long-wall coal cutters built by the Diamond Coal Cutter Company, of England. The installation also includes Ingersoll-Rand temple electric-air drills, a Sullivan short-wall machine, and various other devices, all electrically operated by an A. C. current of 440 vots. On the surface there is also a Bleichert ropeway.

COMPRESSED AIR FOR CHIROPODISTS

Compressed air is a necessity to any up-to-date and fully equipped chiropodist. He has so many and such frequent calls for it, as told in Emerson's Monthly, that it would seem impossible to get along without it.

In the first place, as soon as a foot is presented to the chiropodist, he immediately sprays it thoroughly with some antiseptic solution, such as a 2 1-2 per cent carbolic solution, or a 1-2000 bichoride of mercury solution, thereby minimizing the danger of infection.

He begins to cut away the corns and other excrescences, and in so doing encounters one or more raised capillaries which immeditely begin to bleed—not copiously, but still enough to alarm most patients. If the chiropodist knows the ropes, he will at once apply the compressed air directly over the slight hemorrhage and in a moment or two coagulation will have set in, and the abraded skin thoroughly sealed before even the patient is aware that there has been a hemorrhage.

Compressed air is aseptic from the fact that micro-organisms cannot live therein, hence there can be no danger of introducing germs into the wound by the direct application of compressed air. Most chiropodists, after they have removed an ingrown portion of nail from the groove of a sore toe, insert pledgets of cotton therein for the purpose of absorbing the moisture and drying the groove. This in many instances is a painful procedure and could well be abolished, the same purpose being accomplished painlessly by simply blowing the compressed air into the groove. In an instant the groove will be dry in the same manner as a cold wind will dry the sidewalks after a rainstorm.

In cases of inflamed corn or bunion which have just been painted with iodine, the stream of compressed air blown thereon forces the medicament into the skin, with the result that the therapeutic action is quicker and more effective than if simply allowed to dry thereon. In abscesses or sinii, where a caustic such as pure carbolic acid has been employed to destroy the lining membrane, a most favorable result can be obtained by forcing a stream of compressed air into the cavities.

WE ARE WONDERING WHO IT WAS

The New York state law governing the conditions under which labor may be employed in an atmosphere of compressed air, has recently been radically amended by the Legislature. It is printed in the *Compressed Air Magazine*, October 1913. page 6998. A well known authority on compressed air engineering has called attention to two oversights in the amended law, in that it takes no account of the temperature nor of the breathable condition of the air as determined chiefly by the volume furnished.—*Robert Peele in Mining and Scientific Press.*

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THE NEW YORK SANDHOG

New York City would seem to be the special and only permanent habitat of the sandhog. Incidentally and occasionally his services are apt to be called for anywhere in the world, but when the special task is done that ends it for that locality, while in the metropolis and its environs there is always something doing in his line.

He has laid the foundations for the four magnificent bridges, has driven nearly a score of tunnels under the two rivers, the great Catskill aqueduct has not been completed without his aid, and all the tall office buildings of lower Manhattan are primarily the monuments of his strenuous industry. On a succeeding page we reproduce an interesting and eminently readable article from the Evening Post, of New York, which deals with the latter phase of his employment.

There stands to-day in a central position in the City of New York one of the most notable buildings in the world not alone in the fact that it is the tallest building ever erected by man and put to practical service in its entirety. It is one of the most beautiful buildings in the world, as doubtless will in time be widely recognized. Perhaps the most notable thing about the building is the comprehensive reach of skill and invention which have made its erection possible, and which are embodied in its details of design and construction and in its various adaptabilities. Very different is the job of the sandhog in the caisson in baring and leveling off the rock surface when it is reached, and then in laying the concrete filling of the caisson which is eventually to sustain the weight of the vast superstructure, very different is his work from that of him who gilds the topmost pinnacle, and between these two all the constructive trades and most of the decorative arts have found numerous employment.

The range of vertical depth which limits the sandhog's working possibilities is scarcely over 100 feet. His special services are not called for in a downward direction until water level is reached, and human endurance, with any margin of safety ends at an air pressure of about 50 lb. gage. It is quite remarkable that practically all the calls for sandhog work in New York and its environs are within the sandhog limits. These were not exceeded in the various tunnel enterprises or in the bridge foundations, and if, as seems not impossible, all of lower Manhattan is to be covered with lofty buildings which must have rock foundations the sandhog will be able to guarantee them.

There is just one stunt which the New York sandhog must decline. The bridging of the Hudson would be a vastly cheaper and easier proposition if a pier could be placed in the middle of the river, but the rock lies far too deep and calls for a rooter who has not yet appeared.

AMERICAN ENTERPRISE AND THE ROGLER VALVE FOR AIR COMPRESSORS

There is a distinguished American firm that makes, among other things, air-compressors. It established an office in Johannesburg and supplied air-compressor equipments to virtually all the mines in South Africa. It established an office in Germany and sold air-compressors there.

American air-compressors were standard, German air-compressors were primitive. But the German scholar who gives his life to a verb is reinforced nowadays by the German scholar who yearns to devote the whole mundane career of his immortal soul to a valve. German air-compressors grew better and bolder till they took the German market Then they carried the war into Africa; and the time came when the Transvaal mines were equipped with air-compressors not from American and not from English but from German workshops.

This triumph was not merely commercial. It was not achieved merely by manufacturing a sales campaign. It was achieved principally by designing a valve. The German air-compressors, as described by the American firm whose experience we are here recounting, "were the result of a long period of scientific study by German engineers who succeeded in producing what are known as 'plate' valves (for both steam and air ends of compressors) which have resulted in very high efficiencies."

So, through a technical inquiry which the United States could not prevent, Germany came to a leadership in certain elements of air-compressor design.

What then did our American firm do? It did what, if done in similar cases by all American firms, would keep us continuously at the tip of the wedge of progress. It determined to take instruction wherever instruction could be found. Its method was singularly vigorous. Instead of importing German books and German drawings, fragments of German knowledge, it engaged, as special adviser, a German professor who comprehends all that there is in the books and in the drawings, and more.

This scholastic assemblage of air-compressor progress, who lives in academic shades cast by chimneys instead of by trees, a man as much of alert practice as of studious research, now comes to us with air-compressor lessons from a country which, only a generation ago, was an air-compressor pupil of ours—and a backward one.

Brains of full human weight are being flung at the problem of invention on that side, as well as on this side, of every sea and of every national boundary-line in the civilized world. The nation that wishes to lead must everlastingly study the accomplishments of other nations; and humility becomes an important mental trait for international success.—*William Hard in Everybody's Magazine, December.*

AIR WASHING AND ITS RESULTS*

Clean air in motion and of proper temperature and humidity is necessary to indoor comfort. Our concepts of ventilation are undergoing a change. Slight reduction in the amount of oxygen or slight increases in the amount of carbolic acid in the air we breathe are no longer feared. The human body can automatically adapt itself to slight changes in the proportion of these gases. It is more difficult for the body to adapt itself to temperature changes, and these may cause more or less discomfort and damage. The heat relations of the body are complicated, involving heat production within the body, affected by food and by physical and mental exercise; heat transference within the body from the interior to the surface; and heat elimination at the surface, for human beings live normally in an atmosphere cooler than the body. Heat elimination is itself a complicated matter: it is lost by conduction, by convection, by radiation; it is affected by the temperature and humidity of the air, by the clothing worn, by the perspiration produced and evaporated.

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*From a paper at the International Congress of School Hygiene, Buffalo, Aug., 1913, by George C. Whipple and Melville C. Whipple.

We know at a matter of universal experience, that it is uncomfortable to remain in air that is still, or, as we say, that is "dead." If the air that we exhale remains so near our faces that we rebreathe a portion of it at each succeeding breath, a feeling of oppression and discomfort ensues. Air stagnation also forms an atmospheric cloak about our bodies which affects their heat conditions. Mere stirring of air often changes disconfort to comparative comfort. No system of ventilation can be regarded as satisfactory that does not cause a sufficient circulation of the air.

Another thing that we need to appreciate is that the air that we breathe should be clean. Of course, the extremes of this quality of cleanliness have been recognized. We know that people who work at dusty trades, in dust-laden air, sicken and die of diseases that gain a foothold in the lungs; and we send our sick to the mountains and the seashore, and spend our vacations in the relatively clean air of the woods and fields and upon the water. From time immemorial water that is grossly foul has been regarded as dangerous, but it is only within a generation or so that water which is only moderately contaminated has been regarded as dangerous. If precedent is followed, we shall come to regard as undesirable much of the air that would not by present-day standards be called unclean, as well as air that is grossly laden with dust and foul gases.

LOCATION OF FRESH-AIR INLETS

Too little attention has been paid in the past to the cleanliness of the air supplied to our buildings. Fresh-air inlets are often located with the grossest disregard for the quality of the incoming air.

The fact of forcing unclean air into buildings is to nullify the result aimed at by ventilation. The presence of dust, bacteria and odors not only renders the conditions uncomfortable and deleterious to health, but it results in attempts at window ventilation, and this means poor ventilation, unequal heat distribution and draughts.

Supplying buildings with unclean air may often be obviated by a judicious choice of location for the inlet duct.

Crowded buildings and dusty city streets will often render it impossible to secure clean air from the outdoor atmosphere without resorting to artificial purification. Just as unclean water may be made wholesome by the employment of Nature's process of filtration, so can unclean air be purified by the application of another efficient process of Nature—namely, air-washing. The purifying effect upon atmospheric air of a heavy fall of rain is well known. A shower is said to freshen the air. Not only are suspended particles removed, such as dust and bacteria, but gaseous impurities, such as acids and ammoniacal vapors, are dissolved and removed, leaving the air sweet and clean.

HOW THE AIR IS WASHED

The process of air-washing consists of passing the air horizontally through a chamber in which water is falling in drops, as rain, or into which it is sprayed. The sprays are obtained by forcing the water out of perforated pipes or through nozzles placed across the ducts. When the sprays intersect they are said to form a curtain. Besides the washing chamber there are heating or tempering coils in the ducts or in a separate chamber, and devices for controlling temperature, a primary object of air-washing in the past having been that of conditioning the air with respect to its temperature and humidity. The water used for washing is circulated by means of a pump, so that it may be used over and over in the spray chamber for a considerable time. If desired this water may be cooled so as to influence the temperature of the air.

Comparison of the dust counts in the air before and after passing through the water showed that in the case of the five Boston washers the percentage removal ranged from 27 per cent. to 87 per cent., and averaged 54 per cent., while the removal of bacteria ranged from 37 per cent. to 88 per cent., and averaged 64 per cent. Generalizing from the data obtained, it is fair to say that the air-washing process as practiced romoved about two-thirds of the suspended particles—including dust, bacteria and molds.

From a comparison of the analyses of the tap water before use with the washer water after use, it is evident that many substances were removed from the air besides dust and bacteria. When street air was passed through a washer, it required but a few hours to resemble sewage in appearance and analysis.

The presence of sulphurous acids in the air of the business district of Boston was responsible for an interesting phenomenon. These acids resulted from the formation of sulphurous gases during the combustion of coal and, being soluble, were removed from the air and dissolved by the water in the air-washing process. As long as the water contained alkalinity the sulphuric acid was neutralized, but after a certain length of time an excess of acid was present. This condition was found in several washers. Where it occurred in a washer constructed largely of copper, the acid dissolved this metal and formed copper sulphate. As a resut, there was established a sort of automatic process of disinfection, and the numbers of bacteria found in the washer water were very low.

A SAVING OF HEAT IN COLD WEATHER

The advantage of washing and recirculating the air lies in the great saving of heat in cold weather. Mr. D. D. Kimball, who designed the ventilating plant at Springfield, estimated that when the out-door temperature was 32° F., the saving in cost of operation effected by recirculating washed air was 40 per cent., while with an outdoor temperature of 0° F., the saving was 50 per cent. The use of less coal at Springfield, when the air was being recirculated instead of being drawn in from outdoors, was plainly evident and was commented upon by the engineer in charge of the Springfield plant. In the summer the washer may be operated as a cooling plant to keep down the temperature of the indoor air, or with the windows open it may be shut down to save expense.

The common standard of 30 cubic feet of air per capita per minute, which is now generally applied to schoolhouses, was based upon the idea of keeping the carbonic acid down to a fixed amount. When it became recognized a few years ago that carbonic acid was a negligible factor, some made the inference that a smaller volume of air would suffice. They failed to consider that circulation of the air is of itself one of the essential elements of indoor comfort and a necessary feature of good ventilation.

THE SANDHOG AND THE SKYSCRAPER

The constant multiplication of tall office buildings in New York City has served somewhat to blunt the sensibilities to the enormity of the enterprises as they are completed. Yet even the most disinterested cannot help gazing upward occasionally with something of a thrill of appreciation, while buildings are under construction and the huge steel skeleton is working skyward. It is no longer a strange sight to see a workman swinging far out into space, so far aloft as to seem a mere insect clinging to a tiny thread. All know that he is mounted on a great steel beam that is on its way upward and that the thread he clings to is really the heaviest of steel cables and chains.

The "rough neck," as the steel-worker is called, shares with the underground worker, the "sandhog," the most perilous occupation on the construction work. The "rough neck's" work is spectacular and dangerous, but much that would be of interest to the ordinary observer goes on before the steel frame tops the high board fence which shuts off the view from the excavation. The passerby seldom enjoys more than a glimpse beyond the fence. If he ventures to peek through a crack or pause at a gateway he is invited to move on by a grim guardian armed with the big stick of temporary authority.

So it happens that little is generally known of the "sandhog," whose work begins at the surface and continues downward until somewhere far below his shovel strikes the solid surface of bed rock, upon which to rest the supports that will carry the great building, whose towers will reach toward the clouds.

WHERE ROCK IS FOUND.

The rock formation of lower Manhattan is somewhat peculiar. It has hills and valleys, entirely independent of conditions on the surface. At about Chambers Street, there is a decided valley in the rock. From this point northward, it begins to grade upwards, and crops out close to the surface at streets in the vicinity of the Twenties. Southward from Chambers Street, there is a rise again, and solid rock is found nearer the surface at the Battery than at any place in lower New York.

When the Municipal Building was being erected, announcement was made that its foundations were planted deeper than those of any other building in the city. The excavation was carried to a depth of approximately 140 feet before bed rock was encountered. An official of the Thompson-Starrett Company, builders of the Municipal Building, states that the structure rests directly over the rock valley mentioned, and accounts for the great depth it was necessary to go to find proper footings.

For the new Equitable Building, which will, when completed, be the largest office building in the world, a bed-rock footing for its future thirty-six stories of masonry was found at a depth of approximately 83 feet below street level. The foundation wall is 6 feet thick and extends 936 feet all the way around the great excavation. This wall extends upward from bed rock about 55 feet, where the building wall proper will rest upon it.

The foundation was built in sections and then locked together. Each caisson section is six feet wide and twenty-five feet long, and a foreman and six "sandhogs" were employed in each under section. A strong air pressure was used to keep the water from driving the men out. Varying pressures of air were used up to twenty-five pounds to the square inch. Under such a pressure, experienced workmen can dig and drill for several hours at a stretch without injury. Under heavier pressure the shifts are shortened materially.

Caissons are equipped with a shaft about three feet in diameter, through which a bucket runs up and down, removing the earth as it is loaded below and serving as an elevator to take the workmen in and out. Two men usually ride in the bucket at once. The bucket, when loaded with passengers, is stopped in a lock at the top of the shaft. Here the air pressure is gradually increased to equal that below, if the bucket is going in, or diminished to normal, if the bucket is on the way out.

DANGER AND PRECAUTIONS.

Two men are continually on watch above ground, when there are men below. One is the lock-tender, who operates the lock at the top of the shaft, and the other the gauge-tender, who watches the air pressure. The engineer of the hoisting engine is also an important link for he must control the lightning-like wind of the cable around the drum in order to prevent any accidents to the bucket as it rushes up and down. An air-pressure whistle operated from below gives the signals to the lock-tender. He repeats back the signals by hammer taps on the metal shaft.

The signals vary according to the pre-arrangement of the working crew, but they operate somewhat as follows: Bucket down, 1. Bucket up, 3. Man coming up, 4. Danger is usually 5 toots of the whistle. Two is seldom used because liable to be confused with 1. All signals are given in multiples of 2 so that a call of 5 would be 2 toots—pause—2 toots—pause—then 1 toot.

Caissons were used only on the outside foundation walls or cofferdam of the Equitable building. The entire outside wall was completed to bedrock, and then powerful pumps sucked all the water out of the earth inside the walls. Pillar excavations are now being made without the use of air pressure, and only sheet piling or planking is necessary as a lining to the holes to prevent cave-ins.

A good many questions have been asked by the curious about the great boiler-like tube labelled "Hospital Lock," which is placed at the street level, wherever air-pressure work is in progress. This lock is required by law, and it is so constructed that a sick or injured workman can be put back under air pressure when brought up hurriedly from below. To take the air too suddenly or to be released from it too soon is exceedingly dangerous. Sudden changes of air pressure are responsible for "the bends," a dreaded, paralytic affliction of the underground worker. A patient suffering from an attack of this must be put back under air pressure for awhile and released from it gradually. All of which goes to show how interesting and important is the work of the "sandhog." He has surely come into his own and he is a busy man nowadays.
—*The Evening Post*, New York.

So-called artificial lava is a newly patented mixture designed for heat and electrical insulation. Talc and magnesium silicate are heated to about 1850 deg. Fah., and while in a semi-molten condition the mass is shaped under high pressure.

NOTES

A village for workmen who will construct the Rogers Pass Tunnel on the Canadian Pacific Railway at Glacier, is to be built. On account of the heavy drifting snow, the houses will be elevated on stilts about 10 ft. above the ground and connected by bridges.

The injection of sugar into the veins of patients apparently dying from heart failure and exhaustion from various diseases, not only restores heart action, but produces a remarkable improvement in the general condition. Such is the substance of a communication from Dr. Enriquez of the Hospital de la Pitie, to the Academy of Medicine. The results in many cases are said to have been almost miraculous. No ill effects were shown.

If compressed air is handy, make an atomizer for spraying the soapsuds on the milling cutters used in the Lincoln miller. All that is needed is a ¼-in. gas T, a piece of ¼-in. pipe long enough to reach into the lubricant trough around the table when the cross part of the T is on a level with the cutter. Another piece of ¼-in. pipe with a ¼-in. globe valve screws into one side of the T and serves as a connection for the air, which should be at about 8 to 12 lb. pressure.

The address of the Weber Subterranean Pump Company, whose pump was described in our January issue, is 90 West Street, New York City.

Tufbrec is the name of a new building material recently discovered at Mount Angel in this state. The deposit covers hundreds of acres. It is composed of fragments of rocks of volcanic formation, and because of its numerous dead air cells is said to make an ideal fire and sound proof material.

One of the longest railway tunnels in North America is to be built for the Canadian Pacific Ry. The tunnel is located in the Canadian Rockies near Rogers Pass. It will have a total length of about 28,000 ft. Its purpose is to lower the summit level and improve the grades and alignment of the Rogers Pass division.

One of the recent developments in refrigeration is the use of "oxygenized ice," which is made simply by adding peroxide of hydrogen to the ice while it is forming. This ice is slightly tinted with some soluble dyestuff, and is used only for refrigeration purposes without contact with food products.

In a new German refrigerator, comprising the usual insulated chest with an ice compartment on top, the air is drawn out of the refrigerating space and forced over the ice by means of a motor driven air pump. The air after being thus cooled is again driven into the refrigerating space, and so on continuously.

The following is from one of our exchanges which shall be nameless:

"When using a pump during shaft-sinking, the disposal of the exhaust air or steam sometimes causes trouble. To overcome this, and have a quiet shaft and less annoyance to the miners, it is a good plan to exhaust into the water column going to the surface or elsewhere." If they would only tell us just how they do these funny stunts!

The Columbus Oil & Fuel Co., subsidiary to the Columbus Gas & Fuel Co., Columbus, O., will arrange to secure a supply of gas from West Virginia fields. It has acquired gas and oil rights on 125,000 acres, and has options on 75,000 acres additional, said to require an immediate investment of $400,000. The proposed line will include 90 miles of 16 or 18 inch pipe, 30 miles of 12 inch and 90 miles of 10 inch, with an approximate total cost of $2,000,000.

At least 100 cubic feet of air per minute should be allowed for each man in the mine and 500 feet per minute for each animal. In the anthracite district of Pennsylvania 200 cubic feet per minute is required. If the mine makes inflammable gas, there should always be allowed at least 150 cu. ft. of air per minute for each person. There should be a separate split of air for every 50 to 100 men, depending on the laws in force in the state where the mine is located. By this provision, air is supplied without excessive velocity and the products of an explosion in one section may not invade another.

It is estimated that all the steam plants in the United States produce a total of 16,000,000 hp., while the 1,000,000 gasoline automobiles in use, averaging 25 hp. each, have a total output of 25,000,000 hp. In addition to this there is 15,000,000 hp. generated by motor boats. This brings the total energy developed by movable gasoline engines in the country up to 40,000,000 hp., not including the utilization of this form of power on the farm. An estimate for 1913 places the consumption of gasoline for automobiles alone at 17,000,000 barrels, and no one dares seriously to ask how long the supply will last. We may always console ourselves with the belief that something else will come along.

An electrically operated device for measuring gas, and having a capacity of 100,000 cubic feet per hour, is being used by the Citizens' Gas and Electric Company, of Waterloo, Iowa. The action of this meter is dependent on the electrical heating of the gas in passing through the measuring chamber. The temperature of the gas before and after passing the "heating grid" is measured by two electrical resistance thermometers, which, by means of a relay, adjust the grid current so as to maintain a constant difference of temperature. This current is thus a measure of the amount of gas passing through the grid, and is measured by an ordinary watt-hour meter calibrated directly in cubic feet of gas. An electrical chart recorder is also installed on the meter panel, and gives a record of the rate of flow of the gas.

A lecture was recently given to the Birmingham Metallurgical Society by Mr. Alex. E. Tucker, F. I. C., on "Recent Improvements in Welding," in which the conditions for successful welding were discussed. Mr. Tucker showed that the thermit process, in which aluminium powder was used, was of great use in the Russian-Japanese war, and had been the means of repairing extensive damage done to the Russian fleet. The replacement of acetylene by hydrogen in the cutting and welding of steel was also discussed. Mr. Tucker pointed out that the difficulties of making successful welds with acetylene in the case of parts of engines and machines was very great. There was always the risk of carbonisation on the one hand and oxidation on the other. This was not the case when hydrogen was used, and modern practice showed the reality of these objections.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 2.

1,079,935. HUMIDIFIER. Clarke S. Drake, Milwaukee, Wis.

1,079,985. FLUID PRESSURE REGULATOR. Julius M. Kaminsky, Indianapolis, Ind.

1. In a regulator of the flow of fluid, the combination with a conduit, of a spring coiled longitudinally therein and normally expanded with one end surrounding the passage of the fluid, so that the fluid must flow through the convolutions thereof, and a head on the other end of the spring constructed to give a passage for fluid past it of a constant caliber which is greater than that of the passage through the convolution of the spring during the period when the flow through the regulator is being changed.

1,080,063. AIR-COMPRESSOR. Ebenezer Hill, Norwalk, Conn.

1,080,095-6. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,080,106. SPRING AND PNEUMATIC WHEEL. Joseph A. Gray, Norwalk, Conn.

1,080,164. PNEUMATICALLY - ACTUATED MUSICAL INSTRUMENT. August Phillips, Frankfort-on-the-Main, Germany.

1,080,168. GLASS BLOWING MACHINE. John Rau, Indianapolis, Ind.

1,080,170. AIR-GUN. Ernest S. Roe, Plymouth, Mich.

1,080,198. DEHYDRATING APPARATUS. Ernest William Cook, New York, N. Y.

1,080,289. COMBINED AIR MOTOR AND COMPRESSOR FOR STARTING INTERNAL COMBUSTION ENGINES. Harry A. Lord, South Pasadena, Cal.

1,080,322. DISCHARGE-VALVE. Albert L. Brown, Little Rock, Ark.

1. In a compressor, the combination with a cylinder, of a reciprocating discharge valve, a sleeve for guiding the valve, a cap on said sleeve, a removable member extending above the top of the compressor and down into said sleeve, said member fitting said cap and having a restricted passage opening above and below the cap, whereby said valve is cushioned as it moves to its seat by the formation of a partial vacuum in the sleeve behind the valve.

1,080,420. VACUUM CLEANING APPARATUS. James P. Clifton, Buffalo, N. Y.

1,080,452. APPARATUS FOR CONTROLLING AIR AND OTHER GAS COMPRESSORS. Gustave E. Huttelmaier, Scottdale, Pa.

2. Apparatus for controlling the operation of gas compressors comprising mechanism for stopping the operation of the compressor, means for holding said mechanism in inoperative position and means actuated by an increase in temperature above a predetermined limit of the gases being compressed for releasing the holding means and stopping the operation of the compressor.

1,080,469. VACUUM SYRUPING-MACHINE. Willis Grant Murray, San Francisco, Cal.

1,080,471. AIR-GAS APPARATUS. Svend Olsen, Halle-on-the-Saale, Germany.

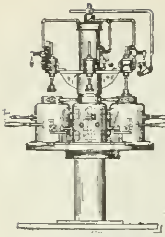
DECEMBER 9.

1,080,538. PNEUMATIC DISPATCH-TUBE CARRIER. Roderick G. Collins, Jr., New York, N. Y.

1,080,582. REGULATOR FOR FLUID-PRESSURE APPARATUS. Auguste Camille Edmond Rateau, Paris, France.

1,080,594. DEVICE FOR SPRAYING LIQUID INTO AIR. Gustav Adolph Schuller, Venusberg/Erzgebirge, Germany.

1,080,706-7. ROCK DRILL. Edwin M. Mackie and Percival F. Doyle, Franklin, Pa.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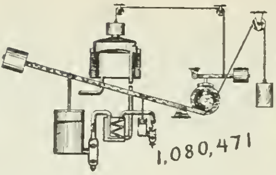
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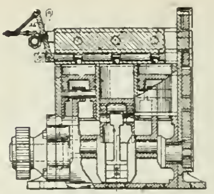
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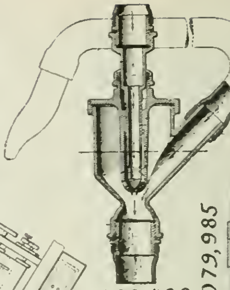
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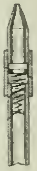
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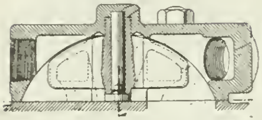
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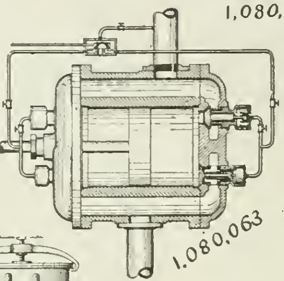
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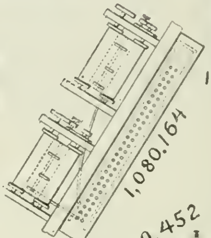
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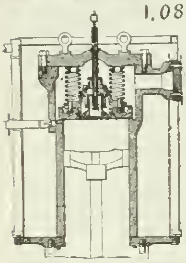
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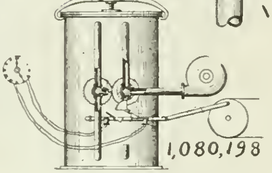
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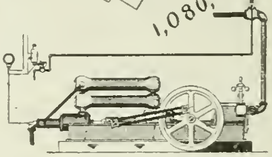
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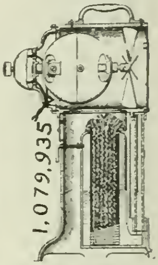

1,079,935

Pneumatic Patents December 2.

1,080,737. AIR-COMPRESSOR: William Everett Ver Planck, Erie, Pa.

1,080,743. ROTARY COMPRESSOR. Karl Ahlquist, Rugby, Eng.

1,080,773. ENGINE-STARTER. Charles H. Myers, Buffalo, N. Y.

1,080,843. DEEP-WELL AIR-PUMP. William L. Morrow, Los Angeles, Cal.

1,080,853. PNEUMATIC TYPE-WRITER. Max Soblik, Dresden-Klotzsche, Germany.

1,080,880-1. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,080,884. REVERSING-GEAR FOR ENGINES. Winzor A. Birchette, Detroit, Mich.

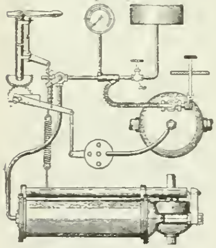
1,080,899. COTTON-PICKER. James W. Dinsmore, Lookeba, Okla.

1,080,900. ENGINE-STARTING MECHANISM. John H. Durno, Rochester, N. Y.

1,081,020. PUMP. William Coyne, Kewanee, Ill.

1,081,175-6. FLUID-COMPRESSOR. Charles Wainwright, Erie, Pa.

1,081,177. GOVERNING DEVICE FOR FLUID-COMPRESSORS. Charles Wainwright, Erie, Pa.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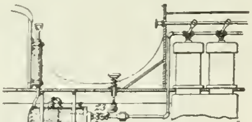
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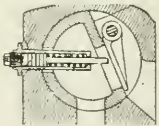
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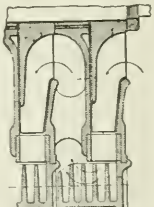
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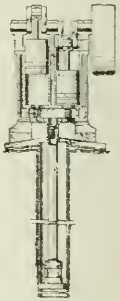
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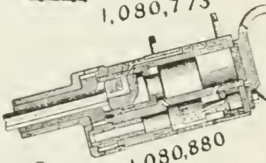
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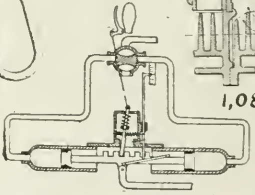
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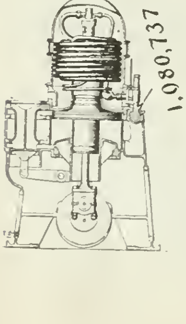
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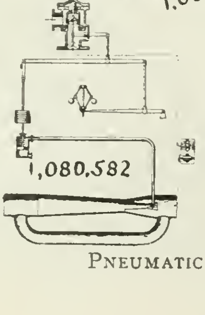
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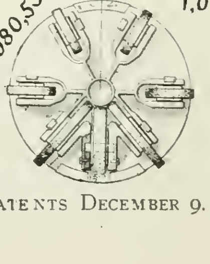
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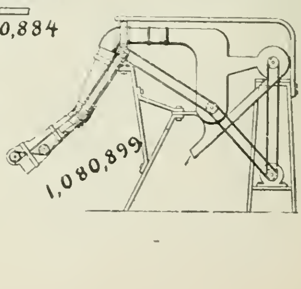
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Pneumatic Patents December 9.

DECEMBER 16.

1,081,316. AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

1,081,325. FLUID-PRESSURE BRAKE. George Oppermann, Hanover, Germany.

1,081,347. PRESSURE-RETAINING-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,081,377. COMPRESSED-AIR LOCOMOTIVE. John A. Forsyth, Fredericktown, Pa.

1,081,436. METHOD OF AERATING SOLUTIONS. Wilton E. Darrow, Amador City, Cal.

A process of aerating a cyanid solution consisting in forming the said solution into a film and admitting air under pressure into contact with said film, as described.

1,081,441. PNEUMATIC-DISPATCH-TUBE APPARATUS. Edmond A. Fordyce, Boston, Mass.

1,081,443. ELASTIC-FLUID ENGINE. William A. Godfrey, Boston, Mass.

1,081,483. PROCESS OF STERILIZING MILK. Charles E. Bonine, Philadelphia, Pa.

1. The process of sterilizing milk, consisting in heating the milk to sterilizing temperature, agitating the milk during heating and maintaining, during heating, a surface pressure on the milk in excess of the normal vapor pressure of the milk.

1,081,523. DEVICE FOR MODIFYING THE PHYSICAL STATE OF AIR. Fortunato Berardi, Naples, Italy.

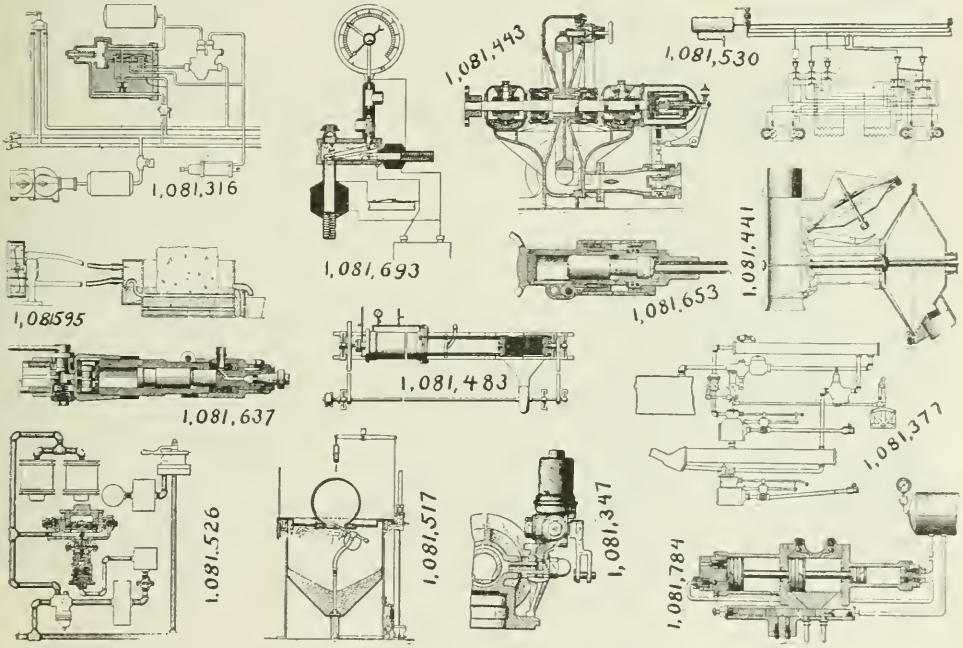
1,081,526. FLUID-PRESSURE MAINTAINING SYSTEM. Frank H. Dukesmith, Buffalo, N. Y.

1,081,547. SAND-BLAST MACHINE. Charles F. Motz, Monaca, Pa.

1,081,550. ELECTROPNEUMATIC BREAKING SYSTEM. William C. Myers, Oakland, Cal.

1,081,595. AIR-COOLER. Arthur Elson, Boston, Mass.

1,081,603. PNEUMATIC PIANO. Charles Freborg, Kankakee, Ill.



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1,081,613. VULCANIZED CAOUTCHOUC AND PROCESS OF MAKING SAME. Fritz Hofmann and Konrad Delbruck, Elberfeld, Germany.

The herein described new material being a vulcanized autopolymerization product of beta-gamma-dimethylbutadiene combined with a small amount of a basic substance, being a whitish non-adhesive substance, containing sulfur, and which on *treatment with ozone*, forms an ozonid which upon decomposition with water yields among its decomposition products acetonylacetone.

1,081,637. HAMMER-DRILL. Albert H. Taylor, Easton, Pa.

1,081,653. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,081,693. ELECTRIC PNEUMATIC-PRESSURE CONTROLLER. Edward K. Parker, Santa Barbara, Cal.

1,081,784. AUTOMATIC PUMP. Gregory John Spohrer, Franklin, Pa.

DECEMBER 23.

1,082,113. PNEUMATIC CONVEYOR. Edward Thompson Diden, Prattville, Ala.

1,082,156. COMPRESSOR FOR AIR AND GAS. Joseph Henry Hurst, Sheffield, England.

1,082,159. ATOMIZER. George J. Kelley, Attleboro, Mass.

1,082,162. ROCK-DRILLING-STOPING-DRILL. John George Leyner, Denver, Col.

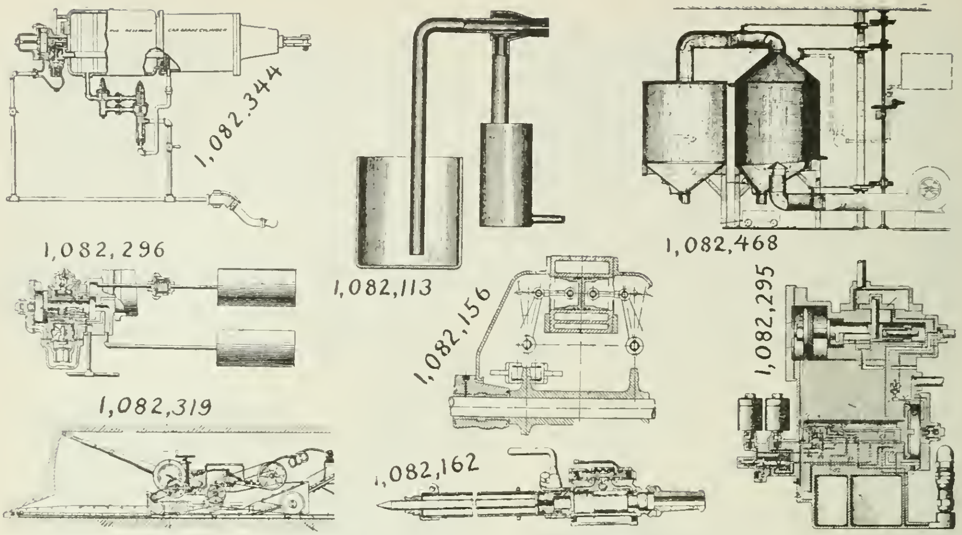
1,082,295. ELECTROPNEUMATIC CONTROL-VALVE MECHANISM. Walter V. Turner, Edgewood, Pa.

1,082,296. FLUID-PRESSURE BRAKE DEVICE. Walter V. Turner, Edgewood, Pa.

1,082,318-9. MINING-MACHINE. Arthur H. Gibson, Easton, Pa.

1,082,344. APPARATUS FOR THE RECHARGING OF AUXILIARY RESERVOIRS OF AIR-BRAKE SYSTEMS. Harry Tilghman Kleckner, Shamokin, Pa.

1,082,468. APPARATUS FOR DESICCATING. Lewis C. Merrell, Syracuse, N. Y.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1,082,492. DEVICE FOR DISTRIBUTING AIR. ADOLPHE E. BOSSE, Pittsburgh, Pa.

1,082,501. EXCAVATING MACHINE. WALTER G. CLARK, New York, N. Y.

1,082,568. VACUUM-PRODUCING DEVICE. HUSTON TAYLOR, Rochester, N. Y.

1,082,580. FLUID-POWER HAMMER. RALPH E. BATES, Philadelphia, Pa.

1,082,595. STARTING DEVICE FOR MOTOR CARS. JUSTUS R. KINNEY, Dorchester, Mass.

1,082,594. IMPELLING DEVICE FOR FLUID-CIRCULATING SYSTEMS. GEORGE W. KERN, Oil City, Pa.

1,082,666. REGULATOR FOR A PNEUMATIC CIRCUIT. FRANK C. WHITE, Meriden, Conn.

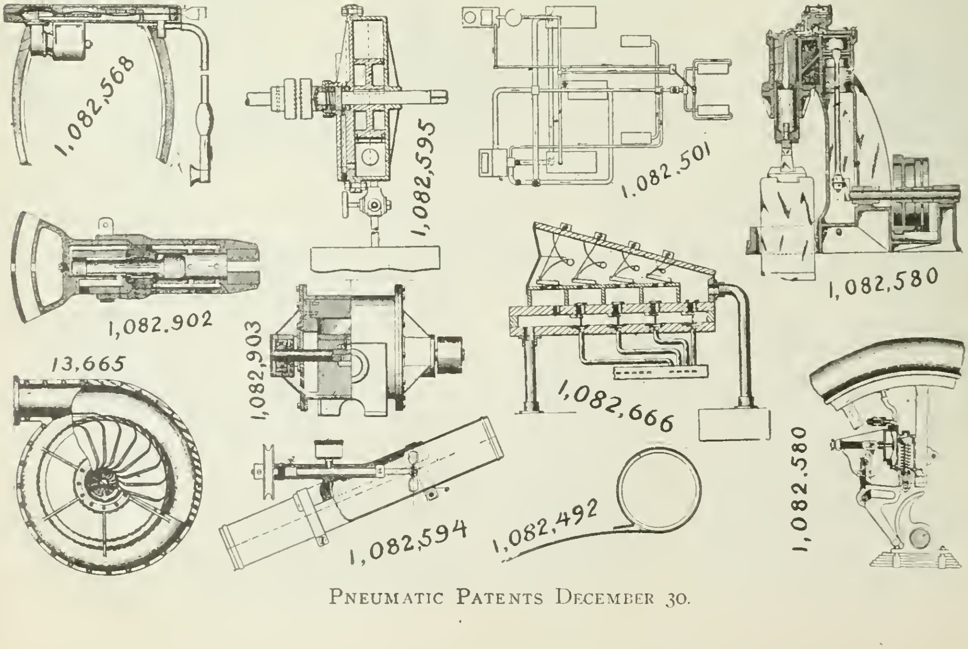
1,082,758. TRIPLE VALVE FOR AIR-BRAKES. SPENCER G. NEAL, Los Angeles, Cal.

1,082,902. RECIPROCATING ENGINE. EDWIN A. PERKINS, New York, N. Y.

1,082,903. ROTAR BLOWER OR PUMP. LOUIS N. PERKINS, Connersville, Ind.

1,082,983. TIRE-INFLATED MECHANISM. EDWARD J. WATSON and RICHARD F. DOWNEY, Milwaukee, Wis.

13,665. (Reissue). CENTRIFUGAL COMPRESSOR. SANFORD A. MOSS, Lynn, Mass.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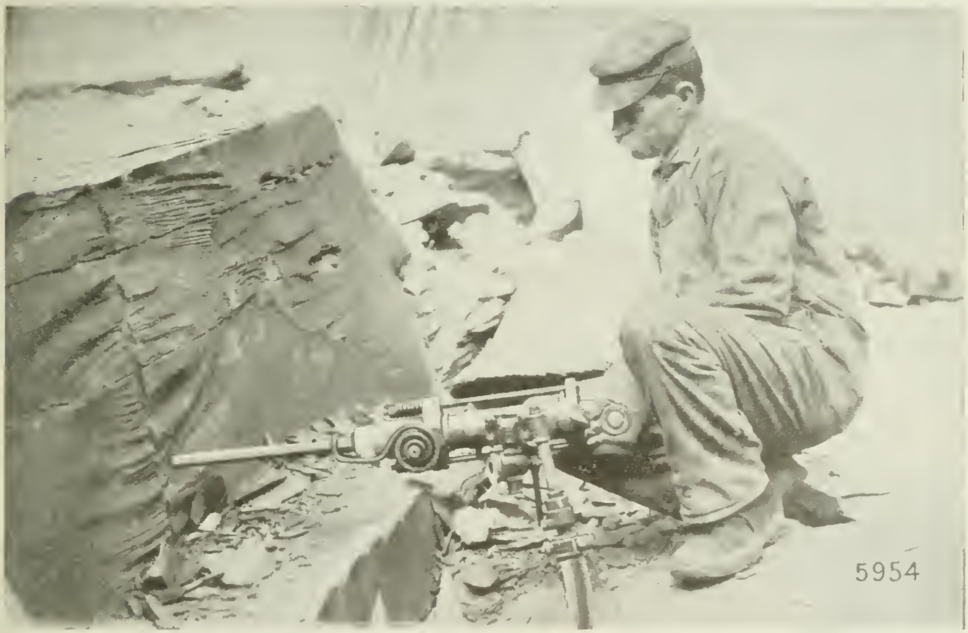


FIG. I. JACKHAMER, AUTOMATICALLY ROTATED, DRILLING HORIZONTAL HOLES IN SLATE.

THE YOUNGER GENERATION OF ROCK DRILLS

BY CHAS. A. HIRSCHBERG.

One of the most useful additions to the rock drill family in recent years is the perfected hand hammer drill, known in various mining sections by different terms of endearment, such as the "Plugger" drill, "Jap" drill, "Jackhamer," etc.

This general type of drill is now extensively employed for such purposes as sinking shafts, digging trenches, drilling out ledges in road work, trimming tunnels, breaking up boulders, quarry work, stripping coal land, picking coal bands, tearing up pavements, foundation work, "glory-hole" mining, etc.

The hand hammer drill is essentially a one-man machine, its weight being 20 to 50 lbs., and this has brought the type into general popularity. This is aside from the fact that the hand hammer drill may be used in restricted quarters, and that more drills may be employed per unit of space due to the absence of mounting and the elimination of helpers.

The adoption of such unmounted drills has been accomplished without any sacrifice of speed; on the contrary, they have proved a material aid in securing results greater than could be obtained with other types, and this is

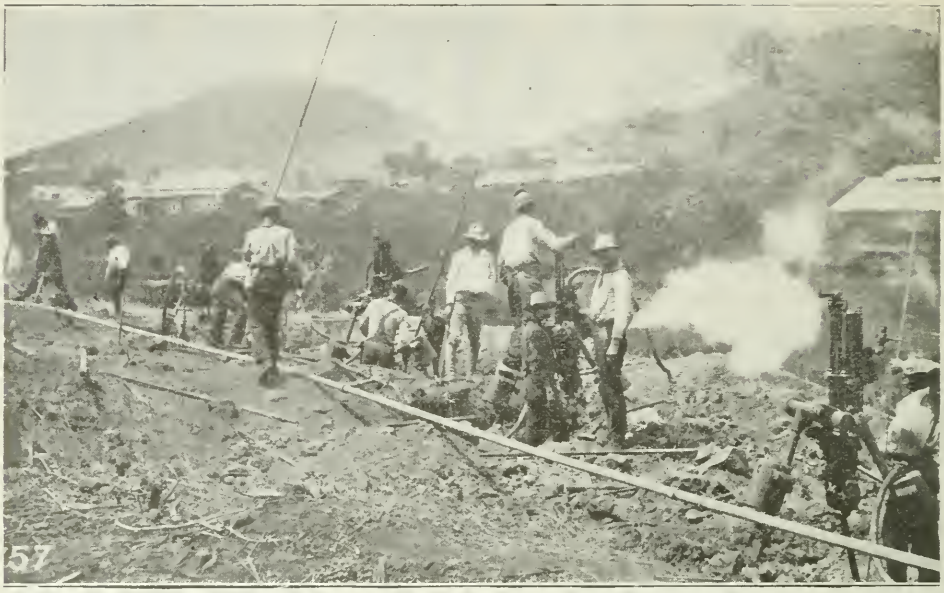


FIG. 2. INGERSOLL-RAND MOUNTED DRILLS ON PANAMA CANAL.

leaving out of consideration certain other advantages inherent in the hand type. It must be kept in mind, however, that this article applies only to work for which the hand hammer type is adapted. There are certain limitations to the possibilities of the type, which will be referred to later.

The time factor in drilling may be considered as made up of the following elements:—

Setting up the drill.
Drilling the hole.
Shifting position.
Removal.

SETTING UP THE DRILL.

The type of drill of which this article treats is used without mounting. Hence the element of time in this regard is eliminated.

DRILLING THE HOLE.

The element of time consumed in drilling the hole may be said to depend upon the size of the hole to be drilled, the method of applying the power to the bit, the facility with which steels may be changed and the manner in which the drill hole is kept clean of cuttings.

With the types of mounted drills in which steel reciprocates with piston, it is necessary to employ steels of large diameter, with correspondingly large bits, owing to the heavy crushing nature of every blow and the severe shocks to which the steel is subjected. Moreover a certain amount of power is consumed in the rubbing of the bit against the walls of the hole, which results in very rapid wear of the bit unless sufficient metal is provided.

In contrast to this, the type of drill under discussion employs the hammer principle for delivering the blow. The steel is not reciprocated with the piston, but rests loosely in the chuck and is struck a great many light blows by a rapidly moving piston, the bit end of the steel being at all times against the rock. It will be evident that the longitudinal movement of the steel is very slight (the rebound only) as compared to the reciprocation of several inches with the mounted type. With the hand type, the great reduction of rubbing of the bit against the walls of the hole reduces the wear on the wings of the bit, so that bits of smaller gauge variations may be employed. In other words, to obtain a given size of hole at the bottom, a smaller size of starter bit may be employed than would be advisable with the mounted type of drill. In the one type (Fig. 3) the steel is rigidly clamped to the piston rod; in the other it rests loosely in the chuck and is prevented from going too far into the cylinder by a collar on the shank of a steel or by means of an anvil block (Fig. 4) interposed between the end of the steel and the piston. The latter constructions mean less

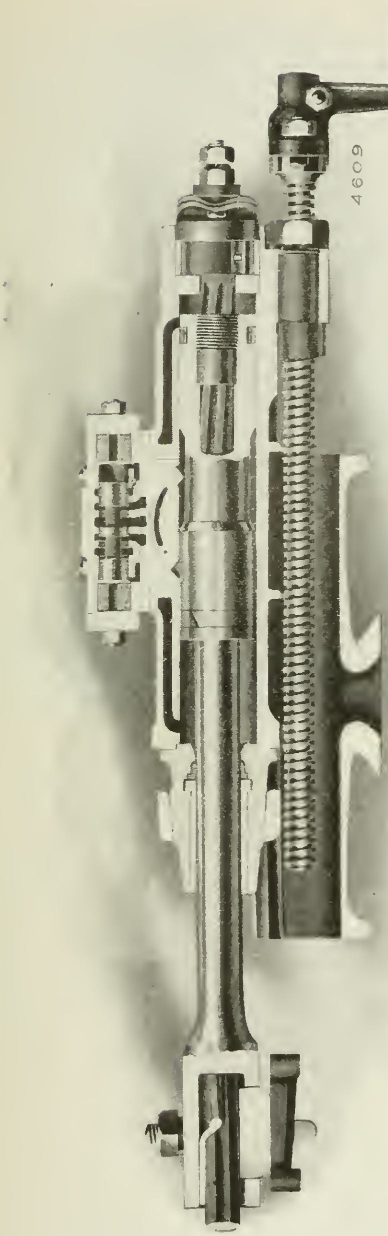


FIG. 3. SECTION OF MOUNTED TYPE OF DRILL.

time consumed while changing steels and in removing steels so as to clean the hole. Of course, with types of drills having automatic hole-cleaning features (Figs. 5 and 8) the time consumed in cleaning the hole may be practically eliminated from consideration.

The time required for removing the steel from the hole is still further reduced when a steel holder (Figs. 5 and 6) is employed, especially if it is of a type that can be slipped into place quickly.

In the mounted type the steel is invariably automatically rotated. In the hand type there are two methods of rotation, by hand and automatically. Figure 7 illustrates a drill of the hand-rotated type in operation. The drill runner must constantly rotate the drill back and forth through an angle of about 45 deg. or the hole will become rifled, with consequent sticking of the steel and delay in removing it. Figure 1 illustrates the self-rotating type in operation and Figure 8 shows the rotating mechanism. It is apparent that a drill embodying automatic rotation will produce a more uniform hole and will relieve the operator of the most irksome part of his work, thus permitting him to work faster and feeling little or no necessity for periods of rest.

SHIFTING POSITION.

The time required for mounting and for the various operations of shitfing mounted types of drills is often greater than the actual time of cutting, whereas with the hand hammer drill this element is practically eliminated, it requiring but a few seconds to shift.

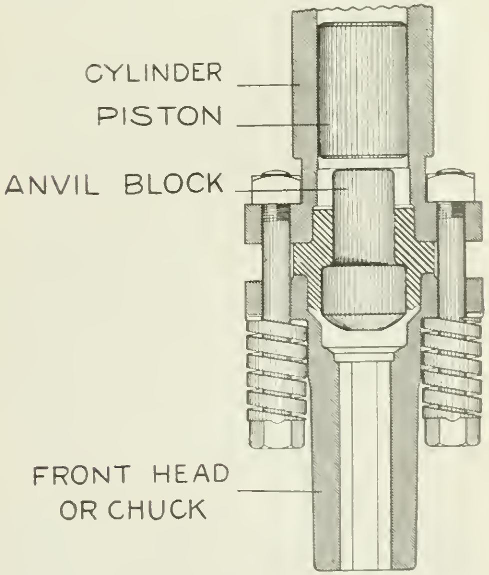


FIG. 4. FRONT HEAD OF "BUTTERFLY" HEAD HAMMER DRILL.

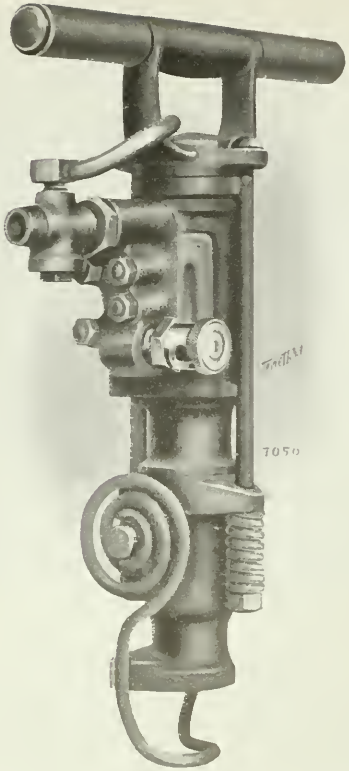


FIG. 5. SHOWING SPECIAL VALVE FOR DIRECTING THE AIR THROUGH THE HOLLOW STEEL.

REMOVING THE DRILL.

When it comes to removing the equipment preparatory to blasting, the absence of mounting, aside from the great disparity in weight (about 250 pounds as against about 40 pounds) is an important item in favor of the new type of drill.

LIMITATIONS OF THE HAND TYPE OF DRILL.

Of course this type of drill has its limitations, principal among which is the depth of hole that may be drilled economically. This varies, depending solely upon the nature of the ground to be drilled. In extremely hard rock the drilling range has been as low as 5 or 6 feet, in medium ground around 12 feet, and in favorable ground around 20 feet.

RECORDS OF ACCOMPLISHMENT.

As might be expected from the foregoing discussion, the actual record of accomplishment has been greatly in favor of the "younger generation" of rock drills for classes of work falling within their proper range.

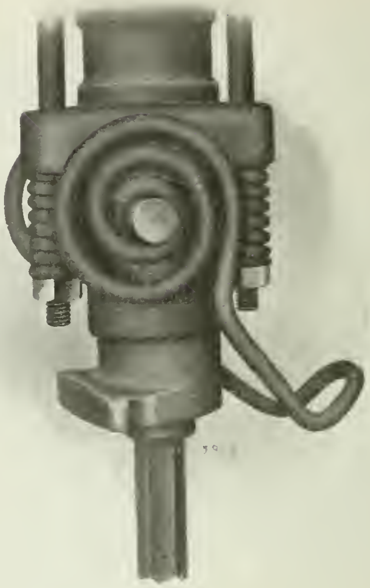


FIG. 6. STEEL HOLDER SPRING UNFASTENED.

ROOSEVELT DRAINAGE TUNNEL

This tunnel now completed, was built to drain the mines at Cripple Creek, Colo., and enable the mines to be sunk to greater depths, while eliminating the heavy cost of pumping. The tunnel is about four miles long, 10 ft. wide and 6 ft. high, with a ditch 3x6 ft. along one side of the floor. No lining was necessary, the tunnel being driven in very hard granite, which made drilling difficult, and made it impossible to break the ground to the bottom of the drill holes. The granite forms a great basin filled with fissured volcanic rock in which the mines are sunk and which is full of water. The original water level was about 1200 ft. above the level of the tunnel. The success of a tunnel in draining the El Paso mine in this district led to the cooperation of mine owners in driving the Roosevelt tunnel for the drainage of the entire district, this tunnel being 1500 to 2000 ft. beneath the surface. A drill hole from the bottom of the El Paso shaft with the tunnel served to drain that mine, and lateral drifts were run to tap different underground water courses or pockets. The present flow is from 7000 to 8000 gal. per min., and the water level in the volcanic rock is being lowered at the rate of about 100 ft. per year.

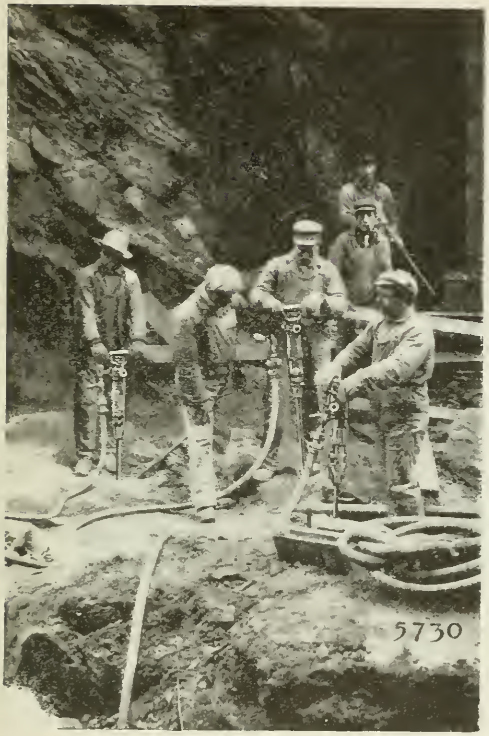


FIG. 7. HAND ROTATED BUTTERFLY DRILLS AT GRAND CENTRAL TERMINAL, NEW YORK CITY.

SELF-IGNITING TEMPERATURES

Experiments of Dr. H. Holm have determined that the temperatures at which substances in contact with atmospheric air at ordinary pressures will take fire are, among others, as follows: Lighting gas, 1110 Fahr.; benzine, 780; petroleum, 716; gas oil, 660; machine oil, 716; coal tar, 932; tar oil, 1075; benzol, 968. These temperatures are greatly influenced by the presence of other substances, which act as catalysers. This is especially the case with hydrogen, methane and ethane, not ethylene or acetylene. Among solids it is the substances with the biggest molecules which most readily burst into flame. As a broad rule, the nearer a substance is to a gaseous condition, the higher the temperature to which it must be exposed before it will kindle.

One of the officers of a certain company recently dictated 296 words for an important telegram. An efficient and careful stenographer boiled it down and fully and concisely covered everything with 91 words.

AIR CONSUMPTION AND MAINTENANCE COST OF ROCK DRILLS

BY CHAS. C. HANSEN.

A number of tests of rock drills are published from all parts of the world dealing especially with Air Consumption and Maintenance Cost. Much of this literature is interesting to read, but some of the information is misleading owing to the fact that so many important factors are left out of the calculation.

If it was possible to establish a definite test that would be equally applicable to all classes and conditions of rock drilling work, and quarry conditions, these test runs would be very instructive. Unfortunately this is not possible; the rock will vary in hardness or resistance to penetration of the drill; even in the same locality different kinds of rock will be found; the air pressure is not constant, and the skill or personal equation of the drill runner is also to be considered. Another important factor in determining the amount of work done by the machine, is the condition of the drill bit; that is, the shape of the bit and the tempering.

It is therefore apparent that these tests are only useful for local comparison, and even here the result may be misleading. This is also true about the cost of up-keep on the machine; the handling, or rather the mishandling, of the drilling machine is largely responsible for high cost of up-keep, but when we consider that the average drill runners of to-day are very inferior men, practically on a par with the average pick and shovel men, it speaks high for the rock drill machines as built to-day, that the average cost of repair is still not unreasonable.

In considering the different rock drill designs the aim has been to produce a machine that will stand this rough handling and yet be of not too great weight, so that it can be easily handled and can be operated properly under the most adverse conditions, with air pressure ranging between 90 and 45 lbs., be simple in construction and yet as economical in air consumption as these adverse conditions will permit.

So much for the manufacture of the mining machine. The other factor to be considered is the condition of the drill steel used, which is altogether in the hands of the mining engineers or mine managers. In some cases

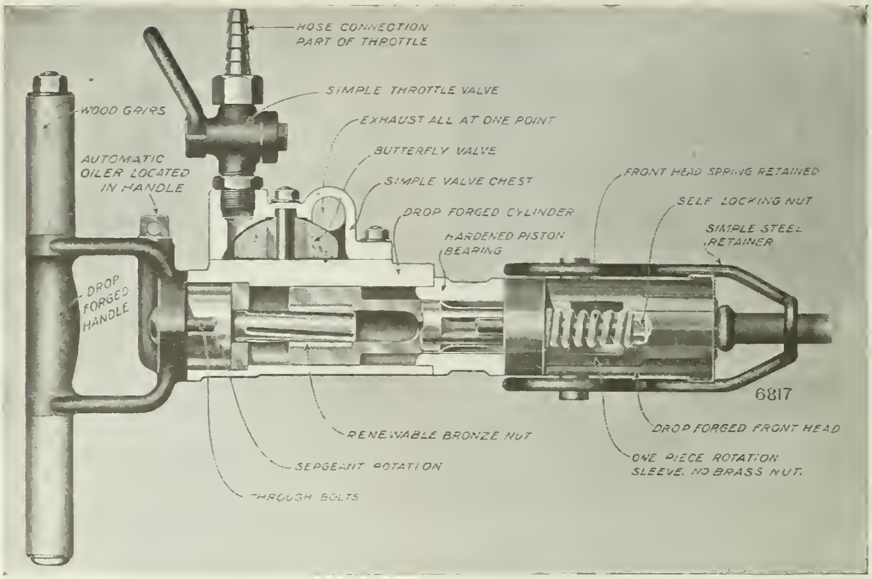


FIG. 8. SECTION OF JACKHAMER WITH AUTOMATIC ROTATION.

the steel question is receiving proper attention: in the majority of cases, however, the steel condition is left to the blacksmith. If he cannot produce the result he is usually fired and somebody else is hired, which may or may not improve the situation. How many mine managers and quarry men pay the necessary attention to the steel conditions? That is to the proper material and to the proper sharpening and tempering of the bit. The shape of the bit largely determines the drilling speed, as the different peculiarities in the rock will require different shape and temper to give the best results. A number of instances have come to the writer's attention in which the changing of either the shape of the bits or the tempering has doubled or trebled the amount of the drilling.

Also it is patently wrong to base the air consumption of an isolated group of drills, or any one drill, on the amount of air used in a shift, without basing this air consumption on the number of lineal feet of hole drilled in the same time.

RULES FOR DRILL TESTS.

It seems only reasonable that tests of a Rock Drill should include the following data:

First, air required for drilling a given depth of hole of a given size in the shortest possible time.

Second, weight of drill, convenience in setting up and changing steels.

Third, cost of repair for a given time.

Fourth, the continued efficiency of a machine over a reasonable length of service, both in air consumption and in drilling accomplished.

In the first item will enter the wages for drill runners and helpers, which, after all, is the largest detail of expense in drilling rock This will also take proper account of the air consumption. In the second item will also enter the wages for drill runners and helpers, as it will affect the amount of work done in a day or shift; that is, this data will determine to a large extent the percentage of time the drills are actually drilling rock. In the third will enter the construction details of the machine, and its ability to run without excessive cost in repairs. In the fourth will enter the construction details as well as workmanship and material of the different parts, as well as wages for drill runners and helpers, also the air consumption, not only for a test run, but for continuous work.

On the efficiency of the man in charge will depend whether the holes are placed properly to get the best results, and whether the machines are handled to their utmost capacity, with proper shape and temper of drill bits. On him will also depend the proper handling of the machines, such as oiling and care, that no unnecessary breakage occurs from rough and careless handling.

The man in charge should know that the machines are handled properly and the steel and bits are of proper shape and temper. Next will come the amount of rock that can be broken per lineal foot of hole drilled, which will depend on whether the holes are pointed or placed at the most economical spacing for producing the best result, and that these holes are loaded with the proper explosives of the proper quantity to give the maximum efficiency. When it comes down to actual figures the mining engineer or hard rock man should figure his cost per cubic yard, or ton of rock broken. In this figure will enter all the charges against this rock, such as labor for drilling and mucking, amount of air used, cost of sharpening steels, maintenance of equipment and the cost of explosives.

It is good business to pay strict attention to the air consumption of the drilling machine, but do we often find the proper attention paid to leaky pipe lines? This loss will in many cases amount to from 25 to 50 per cent of the air consumed in the drills, depending on the condition of workings, whether the pipe lines are getting the proper attention, leaks are guarded against and joints are remade when they have been damaged. Too often this part of the work is slighted or neglected, and perhaps not tackled until compelled by absolute necessity.

Drilling rock is, after all, a business which should have the proper attention in all its various details to give the most economical result.

When steam escapes you can generally see it or hear it, when there is a leak in an ammonia pipe line that also is immediately evident, but a leak in a compressed air line entailing an appreciable loss may go for a long time unnoticed, not that it is more difficult to make the air line tight, and to keep it tight, than the others. An Illinois manufacturer at regular intervals puts essence of pepperment into the air system and then has all the pipes inspected for leaks. If the slightest amount of air escapes anywhere it is revealed by the odor.

VAPOR IN COMPRESSED AIR

BY A. HOFFMAN.

Every user of compressed air knows that moisture in air is to be avoided, if possible, when the air is used in pneumatic tools, drills or, in fact, in any reciprocating mechanism. It is also generally known how the trouble due to moisture is brought about; namely, by the vapor condensing while expanding in the air-operated tool. The drop in temperature which takes place during the expansion causes the water formed to freeze, clogging up the passages of the mechanism, or if actual freezing does not take place, at least the water formed washes out the lubricant, causing the tool to wear out rapidly. The usual method of eliminating moisture from compressed air is by cooling the air after it leaves the compressor, thus depositing a portion of the moisture before it enters the pipe lines, and one of the objects of this article is to show just how effective an aftercooler is in removing this moisture at different degrees of cooling.

MOISTURE REMOVED BY AFTERCOOLER.

Atmospheric air always contains a certain amount of moisture and this exists as a vapor or steam gas, and when present in the air it behaves in every way like steam; it exerts a pressure, the amount of which depends upon the temperature and the quantity of moisture present. At a given temperature air can hold a fixed maximum weight of moisture and when it contains this maximum amount the air is said to be saturated. Air containing moisture behaves in accordance with Dalton's law on mixture of gases, that is, each gas or vapor in a mixture exerts its own pressure and the total pressure of the mixture is the sum of the pressures exerted by the gases independently. Thus, take atmospheric air at 80 deg. F., if the air is saturated with moisture the pressure exerted by the vapor will be the pressure of saturated steam at a temperature of 80 deg. F., which is according to any steam table 0.505 lb. per sq. in. abs. Therefore, if the total pressure of the atmosphere is 14.7, the pressure exerted by the air must be 14.7 less 0.505, which equals 14.195 lb. per sq. in. If, now, instead of being saturated the air contains only 70 per cent. of the maximum amount it can hold, that is to say, the relative humidity of the air is 70 per cent.; then the pressure exerted by the vapor would have been only

$$0.7 \times 0.505 = 0.3535$$

and the pressure exerted by the air would be

$$14.7 - 0.3535 = 14.3465$$

When the mixture of air and vapor enters a compressor the vapor again behaves like any gas, that is, it is compressed adiabatically with the air. The vapor then becomes in every sense a steam gas and at the end of compression it is highly superheated, and only by reducing its temperature can the vapor be deposited as water. *Vice versa,* when compressed air containing this vapor is used in any mechanism where it is expanded, the vapor or steam gas is expanded adiabatically, and as every engineer knows when steam is expanded in this way a temperature reduction takes place and a portion of the steam is condensed, and it is this condensation which causes so much annoyance in the air-operated tool.

The volume of vapor which any volume of air contains can be calculated from the following simple formula:

$$Vs = \frac{Vps}{p}$$

where

Vs = Volume of vapor in cubic feet at pressure p,

V = Volume of air and vapor in cubic feet at pressure p;

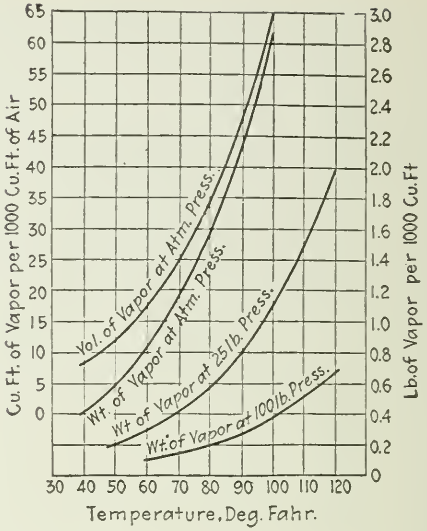
p = Absolute pressure of air and vapor per square inch; thus at sea level and atmospheric conditions $p = 14.7$:

ps = Absolute pressure per square inch exerted by the vapor.

Thus, if the mixture is saturated ps equals the pressure of saturated steam obtained from a steam table at the temperature under consideration.

The weight of vapor present will be $V \times D$, where D is the weight of vapor per cubic foot and if the air is saturated D equals the weight per cubic foot of saturated steam taken from a steam table at the temperature in question.

In the accompanying diagram is shown the volume of vapor in cubic feet which 1000 cu. ft. of air contains at atmospheric pressure when saturated and at different temperatures. Thus, if the temperature of air is 80 deg. F., the pressure exerted by the vapor is 0.505. The volume Vs of the vapor is according to the above formula:



VAPOR IN AIR AT DIFFERENT PRESSURES AND TEMPERATURES.

$$\frac{1000 \times 0.505}{14.7} = 34.3 \textit{ cu. ft.}$$

And this is the quantity also shown by the diagram.

Curves are also given showing the weight of vapor which 1000 cu. ft. of air at atmospheric pressure, 14.7 lb. per sq. in., can hold at different temperatures as well as the vapor which 1000 cu. ft. of free air can contain at 25 lb. gage pressure and 100 lb. gage pressure per square inch. Thus at 60 deg. F. the weight of vapor is 0.8 lb. at atmospheric pressure and at 80 deg. F. it is nearly 1.6 lb. or twice that at 60 deg. From these diagrams it can be determined exactly how much vapor remains in the air after being compressed and then cooled in an aftercooler. For instance, if air is taken into a compressor at 80 deg. F. and if it is saturated with vapor, 1000 cu. ft. of air will contain 1.6 lb. of vapor, and if the humidity is 70 per cent., the amount of vapor will be

$$0.7 \times 1.6 = 1.12 \textit{ lb.}$$

If, now, this air is compressed in a two-stage compressor to 100 lb. discharge pressure, the intercooler pressure will be about 25 lb. If water is supplied the intercooler at 60 deg. F., the air will leave the intercooler at about 80 deg., and the amount of vapor 1000 cu. ft. of air at 25 lb. pressure can contain is found from the diagram to be nearly 0.6 lb. In other words, 1.12 lb. less 0.6 equals 0.5 lb. of vapor has been removed by the intercooler, or 45 per cent. of the moisture originally in the air. If, now, the air leaves the compressor at 100 lb. pressure and is cooled in an aftercooler to 80 deg. F., the diagram shows the moisture still in the air to be 0.2 lb., or 18 per cent. of what vapor was there originally, that is, the intercooler has removed 45 per cent. and the aftercooler 36 per cent. of the vapor.

If instead of cooling the air in the aftercooler down to 80 deg. it had been cooled down to 60 deg., the vapor remaining would only have been 0.1 lb., or 9 per cent. of what it originally contained, and this shows the great importance of cooling the air down to the lowest possible temperature. In the case just cited, by cooling 20 deg. lower, that is, from 80 to 60 deg., one-half of the moisture the air contained was eliminated. Take another example. If the air enters the compressor at 60 deg. F. and 70 per cent. humidity, it will contain about 0.56 lb. of moisture, and if on account of insufficient cooling surface the air can be cooled down to only 110 deg. in the aftercooler, practically all of the moisture originally in the air will remain after it has been compressed to 100 lb.

In order then to get all but a small percentage of the vapor out of the air it must be cooled to a low temperature. It is impossible to remove all of the moisture and if the air is used at the same temperature as it leaves the cooler, it will be saturated with moisture and water will deposit when expansion takes place in the tools. To entirely prevent the deposit of moisture, the air must be cooled to a much lower temperature than that at which it enters the tools, or what amounts to the same thing, the air must first be cooled and then reheated before it is used.

MOISTURE CAUSES LOSS OF WORK.

There is another phase of this question to be considered. That is, how does the moisture in the air affect the work done by the compressor? It has already been stated that the vapor must be compressed the same as the air; therefore, the work required to compress the vapor must be considered as lost work since the vapor is eventually practically all deposited as water in the intercooler, aftercooler or pipe lines, and does no work in the tools. For instance, with 1000 cu. ft. of air entering the compressor at 80 deg. F. and 70 per cent. humidity, as before, the vapor will occupy a volume of 34.3 cu. ft. at saturation or

$$0.7 \times 34.3 = 24 \textit{ cu. ft.}$$

at 70 per cent. humidity. This is equal to 2.4 per cent. of the total volume of 1000 cu. ft. In other words, the volumetric loss due to vapor is 2.4 per cent. If compression takes place in one stage to 100 lb., the work required to compress 24 cu. ft. of vapor will also be 2.4 per cent. of the total work, or 2.4 per cent. represents the work lost in compressing the vapor. If compression takes place in two stages, the loss is a little less because the vapor that is removed by the intercooler does not have to be compressed in the high-pressure cylinder. Calculation shows in the above case for two-stage compression that the lost work will be about 2 per cent. If the air enters the compressor at 100 deg. F. and 80 per cent. humidity, the same reasoning shows that with single-stage compression the lost work is about 5 per cent. and with two-stage compression about 4 per cent.

This is a loss in compression of air ordinarily not considered. It is true that most users of air compressors know the importance of taking air into the compressor at as low a temperature as possible, and the reasons, of course, are that by so doing a greater weight of air is compressed with a given amount of power expended. In addition to this the air should be taken into the compressor as cold as possible so as to reduce the lost work due to compressing the vapor. For instance, if the air is taken from a warm engine room close to 100 deg. temepraturе and laden with moisture, the figures show that the loss due to compressing moisture may be as high as 5 or 6 per cent. of the total work done

COOLING WATER REQUIRED BY WATER VAPOR.

Finally, there is one other question to be considered in connection with moisture in the air; that is, what percentage of the total water supplied to the intercooler or aftercooler is used to cool and extract the vapor in the air. Suppose, as before, the air enters the compressor at 80 deg. F. and 70 per cent. humidity, then if the temperature of the air leaving the low-pressure cylinder in a two-stage compressor is 250 deg., and the air is cooled down to 80 deg. F. in the intercooler, the volume of air and vapor being 1000 cu. ft., the volume of vapor alone is 24 and the volume of air is 976 cu. ft. The weight of this air will be 71.8 lb. and the heat extracted from the air will be the weight multiplied by its specific heat and by the reduction of temperature; that is.

71.8 × 0.237 (250 — 80) = 2893 *B.t.u.*

The weight of the vapor contained in the air as before is 1.12 lb. This must be cooled from 250 to 80 deg., and as the specific heat of the vapor is about 0.46, the heat extracted will be

1.12 (250 — 80) 0.46 = 87 *B.t.u.*

To this must be added the latent heat of the 0.5 lb. of vapor which is actually deposited in the cooler. The latent heat of steam at 0.5 lb. abs. pressure is 1046, which, multiplied by 0.5 gives 523 B.t.u. The total heat, therefore, given up by the vapor will be

87 + 523 = 610 *B.t.u.*

and the entire heat removed by the water in the cooler contained both in the air and the vapor will be

2893 + 610 = 3503 *B.t.u.*

In other words, of the total heat extracted 610 B.t.u., or 17.4 per cent., is taken from the vapor in the air; namely, 17.4 per cent. of the water used is required by the vapor—a most surprising result.—*Power.*

STREET FLUSHING BY PNEUMATIC METHODS

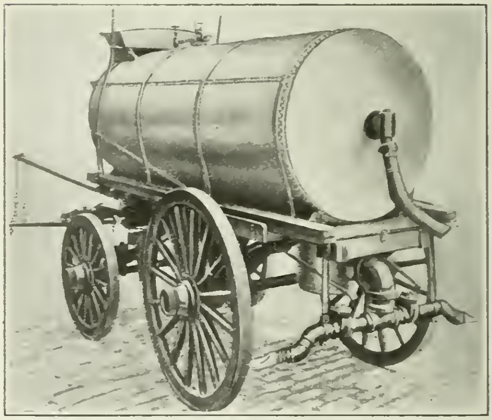
BY CHARLES C. PHELPS.

Modern medical science has taught us the dangers of unclean streets. The antiquated method of sprinkling streets by watering carts keeps down the dust to a certain extent, adding to the comfort of the inhabitants and reducing losses from injury to furnishings, stocks of merchandise, etc., but it cannot be said to cleanse, for it simply moistens and spreads the refuse on the surface and in the crevices, thus hastening decay and furnishing ideal conditions for the propagation of disease germs. When the streets become dry, the dust raised by the winds or in sweeping acts as a carrier for these germs. It is generally believed that many of the diseases of the lungs and tissues of the breathing passages are spread in this way. In many municipalities the flushing action of the rain and melting snow is the only real cleansing which the streets ever receive.

Some cities have abandoned cart sprinkling for flushing direct from the hydrants. Where the water supply is plentiful and hydrants are conveniently spaced, this system has many advantages.

Another system, by pneumatically operated flushing wagons, has been successfully adopted in a number of localities. While the system has been in operation for perhaps eight or ten years, only during the past three years or so has it been used extensively in this country. A large number of these wagons are employed in such cities as Chicago, Washington, Cleveland, Cincinnati, St. Louis, Kansas City, Salt Lake City and Atlanta, as well as in a large number of smaller cities.

The pneumatic system does not work so satisfactorily on water systems having a too low pressure. Twenty-five pounds per square inch is about the practical minimum pressure to give the jet sufficient force. Higher water pressures, however, are being adopted by many cities to meet modern requirements (a notable case being New York's new system, which will carry a pressure of about 200 pounds per sq. in.), so that the field for pneumatic flushing will undoubtedly be widened as its advantages become known.



PNEUMATIC STREET FLUSHER.

A successful flusher of the pneumatic type is shown in the accompanying illustration. It is made by the Sanitary Street Flushing Co., of St. Louis. The sheet steel tank is divided into two parts, the air chamber in front, and the water compartment of about 600 gallons capacity in the rear. The air compartment occupies about one-quarter or more of the entire tank, depending upon the working pres-

PNEUMATIC STREET FLUSHERS IN WASHINGTON, D. C.

sure. These two compartments are connected by piping on top of the tank. There are three valves in this pipe, a pop safety valve, a rear globe valve connecting with the atmosphere and the forward angle valve for disconnecting water and air sections. A gauge is mounted on the rear end of the tank. The outlet pipe leading to the fan-shaped flushing nozzles is connected to a water seal tank under the rear end of the wagon.

The machine must be charged, initially, as follows: After closing the rear valve to the atmosphere and opening the valve between the two compartments, the hose is attached to the hydrant and the machine is filled with water until the air gauge registers about 80 per cent. of the pressure on the hydrant; for example, if the city water pressure is 60 lbs., which is the maximum working pressure of the flusher, then the hydrant should be turned off when the gauge registers 48 pounds. The forward valve is then closed, which will hold the compressed air in the air chamber. The flushing heads are opened and also the rear valve. The rear chamber empties of water, and fills with air through the rear valve. After the first charge of water has been discharged, the filling operation is repeated, the air tank taking up whatever pressure there may be on the hydrant (60 pounds in the example cited above). This completes the operation of charging the machine with the initial air pressure, which suffices for several water loads.

The flushing nozzles are operated by levers from the driver's seat. The air pressure on top of the water causes a stream of considerable force to be projected at a uniform angle against the street surface. These wagons are adapted for sprinkling as well as flushing, by substituting a special form of nozzle.

Some form of low water valve may be installed to prevent the tank emptying completely and so losing its air pressure. The tank is filled as often as desired thereafter without any further manipulation of the valves on top of the tank, in the same manner as an ordinary sprinkling cart. The air chamber, as hinted above, need not be recharged again for some time, but will have to be recharged occasionally as the air pressure gradually diminishes due to absorption by the water and possible leakage.

In Washington, an initial air pressure of about 40 lbs. is used. One tank full flushes about 450 square yards of surface in a strip about 8 feet wide. In Chicago, each machine covers about 22,000 square yards of surface each night, throwing about 1.25 gallons on each square yard. An air pressure of 32 pounds is normally carried.

ECONOMIZING WITH ROCK DRILLS

A paper giving the methods and results of economizing in the consumption of air and in the maintenance costs of rock drills in some of the Rand mines presented by Messrs. E. G. Izod and E. J. Laschinger before the South African Institution of Engineers was published in the November issue of the Journal of the Institution. A considerable portion of this paper is here presented in abstract.

Since the air power used on the Rand is intended primarily for actuating rock drills, it is very important that the air consumption of these machines should be very thoroughly studied by engineers. In times past, economy in the use of compressed air was not considered very important, because it was in many cases absolutely essential to use this air for ventilation, as no other means of introducing fresh air to various parts of the mines existed. This state of affairs is now disappearing and the sooner compressed air is no longer required for ventilation the better. Adequate ventilation by compressed air is too expensive. We would record our conviction that comparatively little is known about rock drills, even by engineers who should know a good deal about them, and that if these machines had received a fraction of the thought and attention bestowed upon machine tools in the fitters', carpenters' and boilermakers' shops, the history of the development of the rock drilling machine would have been a very different story, and the machine itself would have attained a state of perfection and economy unknown to-day.

The mines under the control of the Central Mining and Investment Corporation, Limited, and the Rand Mines, Limited, purchase nearly the whole of their air power from the Rand Mines Power Supply Company, Limited. This air power is measured by air meters which were carefully calibrated before being installed and are under constant supervision and frequently checked. The air power is purchased on the basis of a "unit of compressed air," which represents energy to the extent of 0.641 of a kilowatt hour, which the weight of air in a "unit" will give out under isothermal expansion from its delivered pressure down to a nominal atmospheric pressure of 12.1 lbs. per square inch absolute. The small deficiency of air power not purchased, but required to make up the total requirements of the mines is generated by steam compressors, and the units of compressed air from these are calculated on the results of tests.

Against this consumption of air power, there is to be set the work done. Each mine keeps a record of the "machine shifts" worked underground by the rock drills of various makes and sizes and also a record of winches, pumps, etc., which are driven by compressed air. All these machines are then brought down to the standard rate of a 3¼-in. machine shift. This 3¼-machine shift standard represents the work that should be normally performed by a rock drill with a 3¼-in. cylinder working as usual during an eight-hour mining shift. With regard to the machine shifts actually worked in drilling rock, separate records are kept of stoping and development shifts on each mine.

It is well known that the amount of air consumed per development shift is greater than per stoping shift. By plotting the air consumption of each mine for each month per 3¼-in. machine shift in a position which corresponds to the ratio of development shifts to total shifts, points are obtained which show a mean line of air consumption and which indicate whether at any particular mine more or less air is being consumed than the average to be expected. The indications of such a plot show whether a mine is improving month by month and which mine or mines should have their conditions investigated for probable improvement of conditions.

From an examination of a sample plot so made it appears that in a mine where conditions are normal and care is exercised to prevent waste and to obtain economy in air, when there is no machine development work going on, about 80 units of air power would be required per 3¼-in. machine shift and with 50 per cent. of the drilling on development, about 120 units of air power per machine shift. From this it follows that on a development shift twice as much air is used as on a stopping shift. Since the purchased air is delivered at an average pressure of about 100 lbs. per square inch gage, an air unit represents as nearly as possible 440 cu. ft. of air at 12.1 lbs. per square inch absolute and 60 degrees F., i. e., free air on the Rand. Eighty air units per machine shift therefore represent 35,200 cu. ft. of free air per 3¼-in. machine shift, and the 120 units represent 52,800 cu. ft. of free air.

With regard to mines which take more air than the mean minimum states, one must not at once jump to the conclusion that air is being wasted. On mines with wide stopes where deep holes are drilled, more air is used per machine shift and yet with greater economy in so far as breaking ore is concerned; hardness of rock, width of stope, footage drilled and other factors enter into the problem. At the same time a high air consumption when shown on the comparative record should form the cause of a serious investigation. It is also undeniable, since the miners do not pay for the air they use, and because it is some trouble and requires extra care to save air, and to see that all joints are tight and hose in good repair, that there is need for constant care and supervision.

The fact that large savings in the air power bill of the mines may be effected by paying attention to this matter of air consumption is given by Table I, which shows a progressive diminution of the air power required on the mines of the Central Mining Rand Mines Group for 1912.

TABLE I.—TOTAL DRILL SHIFTS, TOTAL AIR UNITS AND UNITS PER DRILL SHIFT DURING PERIOD JANUARY TO DECEMBER, 1912.

Month.	Equivalent 3¼-in. machine drill shifts, including pumps and winches.	Total air units.	Units per drill shift.
January	73,926	12,018,587	163
February	69,887	11,072,207	158
March	78,887	12,555,015	159
April	75,980	11,272,770	148
May	81,548	11,919.934	146
June	73,839	11,287,577	153
July	82,252	11,561,971	141
August	81,161	11.333,228	140
September	75,581	10,832,301	143
October	80.510	11,339,470	141
November	79,862	11,037.958	138
December	78,545	10,813,549	138

The improvement as between January and December shows a saving of over one shilling (24 cts.) per machine shift in the air power cost.

The method of assessing work done by the arbitrary standard of the 3¼-in. machine shift is no doubt somewhat crude, but it was devised as a beginning for making comparisons to suit present conditions on the Rand. A thorough and true basis would be arrived at by measuring the air power consumed at each point where work is done and an exhaustive treatment of this investigation would certainly be rather expensive.

When it comes to the practical applications of investigations of avoidable losses and the compilation of statistics to show where improvement should be effected, a balance must be struck between the costs of obtaining the data and the amount of savings that can result.

AIR METERS.

We are strongly of opinion that separate air meters should be permanently installed on each working level of a mine and at each point where air is used for specific services. This would enable the engineer to find out at once where air was being wasted or used, in apparently excessive quantities. Strict investigation at particular points could then be carried out and leakage or waste hunted down to its source.

Whatever the make or type of drill, there is one point, however, which is common to all makes and which deserves the closest attention of the mechanical engineer at the mine. We refer to the condition of the drill as a machine. Every mechanical engineer at a mine is, or ought to be, responsible for the condition of the drill (mechanically considered) before it goes down the mine and for the repairs and renewals which are made from time to time.

It is true that the rock drill has rough work to do, is roughly handled by persons who, in many cases, have no mechanical knowledge and that it has to work under the severest conditions that test any machine and militate against economy over a prolonged period.

A DRILL REPAIR SYSTEM.

In this connection we must refer to the system of rock drill maintenance introduced some five or six years ago at the Village Main Reef Gold Mining Company, Limited, and for which our president (Mr. Calder) is mainly, if not solely, responsible. This system consists of bringing up every drill from underground to the rock drill fitting shop regularly, overhauling the drill thoroughly in all its parts and particularly in finishing up the cylinders with reamers, and grinding down the pistons to an accurate fit within a few thousandths of an inch, and thus standardizing cylinders and pistons. Besides this, a record is made of each machine in a book kept for the purpose, and when from the records it appears that a machine has been in the mine for longer than three months, that machine is brought to the surface for overhauling, whether the miner likes it or not.

As the monthly records of air consumption compared with machine shifts at the Village Main Reef showed better results in regard to the use of air than those at other mines, tests on a practical scale were undertaken at various mines in order to judge whether the economy was due to the systems of rock drill in vogue at various mines.

The scheme of testing was to isolate machines at one level on certain mines where a considerable number of drills were working, to install a meter in the pipe serving these drills, and to take the necessary observations, particularly as to the running times of the drills, over a period of about a week in each case. From the figures thus obtained on various mines, fair average data were obtained showing the performances of drills in average condition for each mine, and indicating by comparison the relative efficiency of the state of repair of the drills. By measuring the air for the drills only, the results would not be obscured because of air being used for purposes other than drilling.

The measurement of the air was commenced at the time the first drill started working, and the air was no longer measured after the drills had finished their actual drilling shift, so that no error was introduced because of air being used to ventilate a drive before commencing or for blowing out the holes before charging. Tests were also conducted in each case to determine the leakage in pipes and hose, and this loss was deducted from the total air consumed per shift. The number of drills in the various tests varied from 10 to 16.

A short resume of the results of these tests is given in Table II. From this table it will be seen that the state of repair of the machines on the various mines is reflected, first in the great difference in relative air consumption at the various mines, and, secondly, in the case of the last two tests, the difference at the same mine between the machines in ordinary state of repair and after having been newly repaired for the purpose of comparison.

It will be within the recollection of many of the engineers on the Rand that the test conducted at the Meyer and Charlton in May, 1908, showed very clearly the enormous loss of air due to old machines, as compared with new machines of the same make, the difference in air consumption for the old being 60 per cent. more than for new machines. There does not appear to be any reason why a machine properly overhauled in the fitting shops should not be equal to a new one in so far as air consumption is concerned, if the cylinders, pistons and valves are properly fitted. An engineer who had had a steam engine overhauled, rebored the cylinders, fitted new pistons and rings and valve seats, would feel himself disgraced if the steam consumption figures showed worse than when the engine left the works.

TABLE II.

Mine.	State of repair of drills.	Cu. ft. air per min. of drilling time.	Relative consumption.	Aver drill speed, ins. per min.
Village Main Reef.	Ordinary	103½	100	1.27
A......	Ordinary	122	118	1.20
B......	Ordinary	137	132	1.80
C......	Ordinary	153	147	1.29
C......	Newly repaired	120	116	1.30

In order that machines, either new or repaired, should be sent down the mine in good order and condition, it is advisable not only to run the machine on the block before sending it down, but also to test it for air consumption while on the block. A machine may seem in perfect order, giving high speed and an even beat, but the air consumption test may reveal a serious defect. Very useful data would be obtained also by testing the machines after coming up to be repaired, and before any work is done on them, that is if they are still in running condition.

DRILL REPAIRING BY CONTRACT.

On the Village Main Reef G. M. Company, Limited, a system had been in use for some years of placing the repair work of drills on contract, based on a certain price per 52 machine shifts, for which price the contractor, who is usually the rock drill fitter, had to be responsible for the purchase of spare parts, keeping drills in order, preventing waste of material, etc.

The cost of keeping the drills in order at the Village Main Reef was generally so much lower than the average that the Village Main Reef system was carefully investigated and a model form of contract was drawn up for the other mines. The contract system was then put into operation gradually on several of the other mines, and the results have been particularly satisfactory. The costs have fallen in about 20 months from an average of $42 per 52 machine shifts to a figure of $27 per 52 machine shifts. The Village Main system, which after all, is a common-sense contract system, was slightly modified in one or two cases to suit different conditions on other mines, and generally the contract system is worked as follows:

The rock drill fitter is given a certain price for keeping the machine drills in good condition. The price he is given is for 52 rock drill machine shifts, and at the end of each month the contractor, or rock drill fitter, has on the credit side of his balance-sheet a certain sum which represents the total number of rock drill machine shifts returned by the mine multiplied by the contract price. On the debit side of his balance-sheet is shown the cost of spare parts, labor, etc. The contractor can make what arrangements he likes for the repair of the drills. From the amount left by deducting the debit side from the credit side the guaranteed wage paid to the contractor is taken and of the balance so obtained one-half is taken by the mine and the other half by the contractor. In this way the mine shares with the contractor any savings which may accrue through increased skill in workmanship and care as to waste, etc., and if the price is properly fixed to start with, which, of course, is the essence of the contract system, the contractor can go ahead with his work without fear of having his price cut.

There is a clause in the contract which calls for the drills to be brought up from underground after each one has worked for 156 shifts, and when the drills are taken to the shops they have to be very carefully overhauled and put into first class working order to practically correspond with a new drill.

It is laid down in the contract that the pistons have to be ground and the cylinders have to be reamed, and standard reamers have been supplied for all various sizes to which a cylinder can be bored, usually in steps of 1/32 in. diameter. It will thus be seen that by starting with small cylinders and large pistons, as the large pistons are ground down so the small cylinders are reamed to increased diameters in steps of 1/32 in., and there are always standard pistons to fit standard cylinders.

In the past probably one has looked upon the rock drill as a piece of mechanism which, so long as it will drill, need not be worried very much about, but when the cost of air and the drilling speed are taken into consideration, it can be proved that it is a commercial proposition to pay as much attention to the upkeep of drills as the upkeep of winding engines or compressors.

A COMPRESSED AIR PUMPING FEAT

A duplex direct-acting steam pump of standard make was installed at the 200 ft. level of a certain mine to be driven by compressed air, with the exhaust pipe reaching the 100-ft. level for ventilation purposes. The air-compressor at the collar of the shaft was driven by a Pelton wheel, the supply for which was interrupted during a winter night, by the wholesale freezing of the feeding flume. The pump naturally stopped, the water began to rise in the shaft, and before long had reached the 100-ft. level, and so things remained till the following spring, when the compressor was started again; a few moments later, water issuing from the delivery pipe showed that the pump had instantly responded. This, however, was due, first to the unusual extension of the air-exhaust pipe, which is very exceptional in a pump of that kind, and also to the fact that the rapid inrush of water at the time of stopping had caused the attendant to take a bee line toward upper quarters, leaving the throttle at the pump wide open.—*A. E. Chodzko.*

WATER DIVINING

The hazel twig water-finding business has recently been formally investigated at Guildford, England, and also in France and Germany. In all cases the results have been the same. Sometimes water has been predicted where water was not; sometimes sources of water have been passed over unnoticed; and sometimes water has been found by one and not recognised by others traversing the same spot. The Committee appointed to conduct the trials at Guildford reported that "whatever sensitiveness to underground water may exist in certain persons, of which some evidence has been given, it is not sufficiently definite and trustworthy to be of much practical value. Moreover, the lack of agreement with each other shows that it is more a matter of personal mentality than any direct influence of the water."

ALTITUDE AND FATIGUE

An interesting communication has been presented to the Académie des Sciences by M. Vallot and M. Bayeux concerning the relations of muscular exercise to altitude. They made use of a squirrel confined in a rotary cage, and were able to determine that the animal at the sea level made 6700 turns of the wheel a day. After this fact had been established by repeated observations, the animal was taken in his cage to the summit of Mont Blanc, at which altitude it made only 900 turns a day. When brought down to the plain it made 5000. This experiment clearly shows that the fatigue felt on muscular work by Alpinists is not solely due to the exertions of climbing, even though they take a considerable part in it. As a matter of fact, the person or animal transported without fatigue to the summit finds himself in a medium in which the rarefaction of the atmospheric pressure and the diminution of oxygen are sufficient to diminish muscular energy.

WINTER TUNNELING IN ALASKA

580 feet of 8 x 10 tunnel in hard rock, muck extracted 8300 feet from breast to dump and all piping, track and wiring laid and ready for practical use.

This is the record of "Chief" Paddy O'Neil at the big Sheep Creek tunnel for December, in spite of twenty-four hours off on Christmas day for every man of the shifts. Just a word about that "chief" part. Down at the portal camp where the big Irish tunnel foreman is a czar they all call him "Chief." For eighteen months O'Neil has been living on powder fumes. For that period of time he has eaten and slept tunnel, driving a small army of well organized machine men, muckers, and pipe men into the breast crying "record, record." The big Irishman has one ambition in life: "Break the world's record," and it might—always a chance for a slip in the tunnel game—be done in the month of January, 1914. All depends on the break of the ground and luck—because the crew and machinery is there to do it with.

PADDY IN FULL CHARGE.

"The company gives me the tools, quarters and everything I want and the crew are the best on earth," declared the chief to a *Dispatch* man Sunday. It was in the breast of the big tunnel, thirteen shots in the upper round and ten in the lower round, had just torn out four more feet of tunnel. Five minutes after Paddy had counted the shots, the head mucker was into the breast, the head man on the upper drills and the big cross bar on the waste dump ready to slide into position, and three machine men were dragging their machines to the breast. Ten minutes more and the two machines on the upper bar were chugging away, and fifteen minutes later the muckers had cleared away and the lower bar was up and the two drills on that bar were hammering the steel. Some work, believe me, boys. But that was not all, the pipe crew had laid their pipe, the electrician was already stringing his wires, and the flooring and rail crew were at it. At one time sixteen men were working with a space allowance of one square foot to the man. There was no crowding, cursing or quarreling. Every man, including the chief, who is there at every round of holes and most of the time between, knew his duty, like a well drilled gun-crew on a man of war.

THE MEN ON SHIFT.

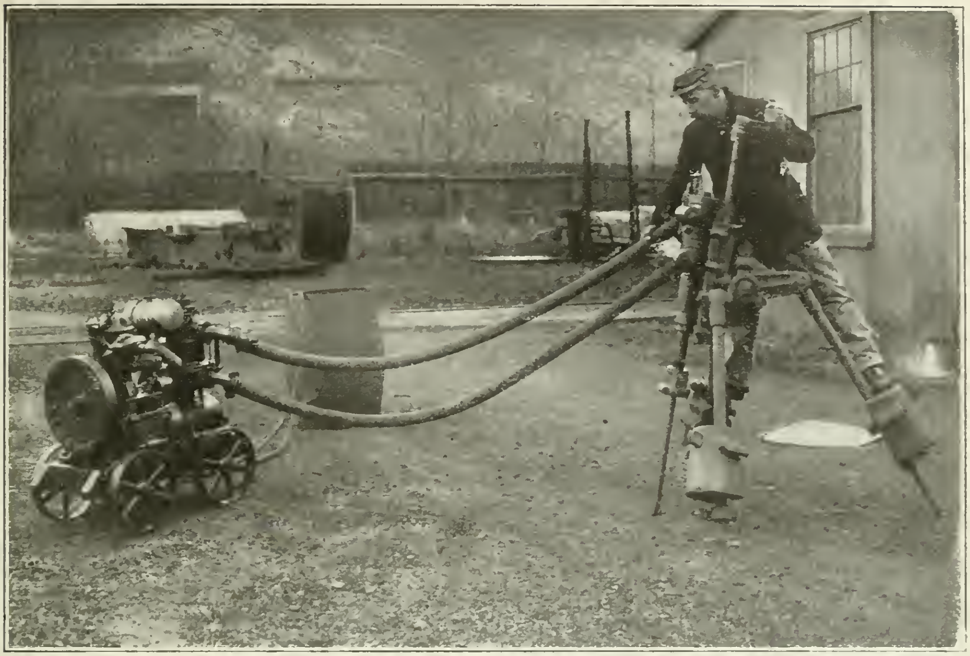
Eight machine men are on a shift, two to the drill, six picked muckers handle the waste dirt and four pipe men belong in each shift. Each shift works six hours and rests twelve. All receive more in bonus than received on straight pay, the machine men averaging close to $10 a day, while the muckers and pipe men run from $7 to $8 a day. But a man has to work, that is to hold his end up.

LOST HIS BONUS.

They tell the story at Sheep Creek of the machine man who lost his bonus. He came to Juneau three months ago and got drunk, overstayed leave, and when he returned the chief said no bonus. Right into the breast he went, and for three months worked without a bonus. To-day he is on the bonus list again, his little jamboree costing him just about $450.

FINISH IN NINETY DAYS.

It is expected at portal camp that the tunnel will be finished in ninety days, and then the husky drillers will get tame and uninteresting work like cutting out stations and sinking shafts, near child's play after the game they have been in for eighteen months. Just what will become of Paddy O'Neil is the question—many portal camp terriers declaring he will become a motion picture actor.—*Alaska Dispatch.*



GASOLINE ACTUATED PULSATOR ROCK DRILL.

A NEW ROCK DRILL OPERATED BY GASOLINE ENGINE

The "Temple-Ingersoll Gasoline-Air" rock drill has been placed upon the American market during the past month by the Ingersoll-Rand Company, 11 Broadway, New York. At present it is made in only one size, and the equipment employs the same type of drill and pulsator as are used with the "Temple-Ingersoll Electric-Air" drilling unit. The electrical equipment of the latter type, however, is replaced by a six horse power, single cylinder, gasoline engine. The gasoline motor, supply tank and pulsator are all mounted on a four-wheeled truck for easy transportation.

It is apparent at once that the "Temple-Ingersoll Gasoline-Air" drill possesses the advantages peculiar to the "Electric-Air" drill, but is also particularly suitable for use in locations where electric power cannot be economically or advantageously applied.

The gasoline engine is of the jump spark type, the ignition spark being obtained from dry cells. The circulating water is obtained from any convenient receptacle placed near the equipment. The splash system of lubrication is employed for the piston and crank pin bearing, and grease cups lubricate the main bearings. A gasoline supply tank of 1¼ gallons capacity, surmounts the engine. The fuel consumption of the engine, running under load, is about two quarts of gasoline per hour, so that the average daily fuel consumption would be approximately three or four gallons.

The drill proper of the "Gasoline-Air" unit is driven by pulsations of compressed air created by a pulsator actuated by the gasoline motor. Gearing transmits the power from motor to pulsator. The air is never exhausted, but is simply used over and over again, playing back and forth in a closed circuit. The pulsator is a simple machine, employing no water jackets.

The drill is the simplest type possible—a cylinder containing a moving piston and rotation device, with no valves, chest, buffers, springs or side rods. The cylinder is larger but the piston portion is shorter, making the weight of the drill unit about the same as, or even less, than that of the corresponding air drill.

Two short lengths of hose connect pulsator and drill, each hose acting alternately as supply and exhaust.

Some leakage of air from the system is inevitable. This is provided for by a compensating valve on the pulsator, which is adjusted to automatically maintain the requisite pressure in the circuit.

The ordinary air or steam driven rock drill takes a full cylinder of air or steam at full pressure each stroke, and discharges it to atmosphere at practically full pressure. No advantage, therefore, is taken of the expansive properties of the air or steam, and as a result an amount of power is wasted without doing useful work.

The "Gasoline-Air" drill operates on an entirely different principle. The closed system is filled with air under a low pressure, which is simply an agent for transmitting the effort of the pulsator piston to the drill piston. The air in the system has been aptly referred to as a pneumatic "spring," unwearing and unbreakable, exerting its pressure on opposite sides of the drill piston and the pressure in the air is analogous to the tension of a spring. That the saving in power is great is proven by the fact that, under ordinary conditions, the drill proper of the "Gasoline-Air" unit uses about one-fourth the horse power required for the usual air or steam drill, of the same work capacity.

The "Gasoline-Air" drill has a stroke equal to, or even greater than that of the air driven rock drill of corresponding capacity. The length of stroke is varied simply by cranking forward in the shell, and both stroke and force of blow may be adjusted by the same means for fast drilling under any circumstances. If a hole should "mud up" or form a "mud collar" in bad rock, the machine can be backed out without injury while running, thus clearing itself quickly. The cushioning is such that the piston, in running, does not normally strike either front or back head. This makes very easy the problem of handling it in all kinds of drilling.

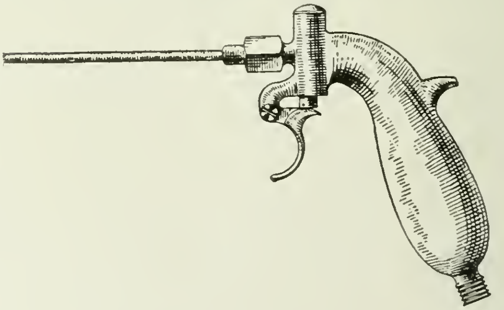
When the ordinary rock drill, whether steam or air driven, sticks or fitchers it simply pulls back with a steady pressure and the steel must be sledged until it loosens. The "Gasoline-Air" drill, on the contrary, when it does momentarily stick, receives on its piston upwards of 400 alternating pulls and pushes per minute; and this repeated pulsation has a tendency to promptly loosen and dislodge the stuck bit.

The system of lubrication of the pulsator is automatic and complete, the "splash" method being employed. While most of the oil drains back to the crank chamber, a portion is atomized and carried through with the air into the drill.

The drill cylinder diameter is 4¾ inches and the stroke is 7 inches. The drill will accommodate octagon steels from 1 to 1⅛ inches in diameter, drilling holes from 1¼ to 2 inches in diameter. The drill feed is 24 inches. The approximate strokes per minute are 440. The machine is designed to drill holes up to about 12 feet in depth.

Economical in power consumption, rugged in construction, easy to understand and operate, efficient in its working, this drill appeals particularly to the small operator, because of the lower installation cost, no compressor or boiler plant being required.

Its field covers quarrying and contracting operations, particularly those in isolated locations where the high cost of coal forms a serious handicap in many cases. Its advantages for winter operations in quarries will also be apparent to those who have experienced trouble from the freezing tendencies of ordinary drills.



PNEUMATIC CLEANING GUN

The cut shows a device about which there is practically nothing to say, as everything about it is so simple and self-evident. A small air hose is connected to the butt of the handle, the nozzle is placed wherever there is any dust or loose material, and then a touch of the trigger does the rest. A long and a short jet pipe of flexible copper is furnished with each gun and these can be bent by hand for reaching places not easily got at. The device is made by the G. H. Dyer Co., 39 Piedmont street. Boston.

AIR COMPRESSORS VERSUS HYDRAULIC PUMPS IN WOOD PRESERVATION

BY F. J. ANGIER*

It is the practice at most timber-treating plants to use hydraulic pumps to force the preservatives into the wood. This is a practical and efficient way of performing that service, and while the hydraulic pumps may have some advantages over the use of compressed air, they also have some disadvantages. When designing the B. & O. plant at Green Spring. W. Va., this feature was given careful consideration, and it was finaly decided to use the air pump. The idea of employing compressed air for forcing the preservative solution into the wood to be treated was, so far as is known to the writer, first adopted by the C. & N. W. at its plant at Escanaba, Mich. Here the apparatus is different from that used by the B. & O., but the principle is practically the same.

In the application of the air-pressure system at the Green Spring plant, there are employed two small upright tanks, called "pressure-measuring-drain" tanks, deriving their descriptive title from their three distinct operations —for pressure, measuring, and drain. In the case of the ordinary pump method, at least two tanks would be required, one for pressure and measuring, and one for drain.

COMPRESSOR ADVANTAGES.

The advantages of the air pump are: Only one tank is required for each retort, that tank serving in the triple capacity of pressure tank, measuring tank, and drain tank; one air pump is ample for three retorts, while one hydraulic pump is required for each retort; the maintenance of one air pump is much less than three hydraulic pumps, and is decidedly cleaner. The air pump requires less attention, and lessens the cost of packing, lubricants, valves, valve seats, plungers, etc.

An air pump is a necessity in plants using hydraulic pumps for blowing back solution, unless those plants are equipped with expensive underground receiving tanks. In the latter case an air pump can be dispensed with in lieu of a large oil pump for pumping solution back into the working tank. The underground receiving tank is more expensive in operation than the air pump, and no doubt this is the reason why so few plants are thus equipped. One air pump can be operated on two or more retorts at the same time without deranging the gage readings. This is not practicable with hydraulic pumps. Experience has taught us that it is practically impossible to maintain a steady and constant pressure on a charge of timber with a hydraulic pump, even though it is equipped with relief valves, while with the air pump this is easily accomplished.

The amount of steam required to operate one air pump is not more than would be required to operate three hydraulic pumps, but as the exhaust steam is used for heating purposes, this feature is not so important.

TABLE 1—COST OF AIR-PUMP SYSTEM

1 air pump (capacity 8 cu. ft. of compressed air per minute at 175 lb. gage pressure)	$1,200
3 pressure-measuring-drain tanks	2,000
Piping, valves, etc. (estimated)	400
Total cost of air-pump system	$3,600

TABLE 2—COST OF HYDRAULIC-PUMP SYSTEM

3 hydraulic pumps	$1,000
3 measuring tanks	900
2 drain tanks	400
1 low-pressure air pump..................	500
Piping, valves, etc. (estimated)...........	600
Total cost of hydraulic system	$3,400

The initial cost of installing the air pump system is, according to the accompanying table, a trifle more than for the hydraulic pump system, but the maintenance is less, and in the long run air is more economical.

With hydraulic pumps there is more machinery to care for, more tanks to look after, and more piping and valves to maintain. There is also more work for the engineer, and unless everything is compactly arranged the the engineer will require an assistant. With the air pump one man can easily look after the entire operation with greater satisfaction and with better results.

[It is proper to remark that in the above table the cost of the air pump or compressor of the given capacity is much too high, and if that item alone was corrected it would no longer appear that the cost for air was higher than for the hydraulic equipment. Ed C. A. M.].

While working on the new survey over the Siskiyous, a gang of men under Assistant State Highway Engineer Kittridge of California struck a three-foot gold ledge which mining men declare to be of a high grade

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*Supt. Timber Preservation B. & O. R. R. Abstract only of paper.

LOW PRESSURE COMPOUND AIR LIFTS

BY A. E. CHODZKO.

Whatever be the exact behavior of compressed air in raising water up a delivery pipe, it will have yielded all of its useful effect if, in course of the process, it expands from its initial to its final, that is, to atmospheric pressure. Now, if (P_1) is the absolute air pressure (that is, the gauge pressure plus atmospheric) and (P_0) the atmospheric, it is easily found that at any particular place, if the compressed air enters the pump at the same temperature as it entered the compressor, the efficiency (E)—that is, the ratio of the work done by the expansion of the compressed air to the work absorbed in compressing it—is expressed by

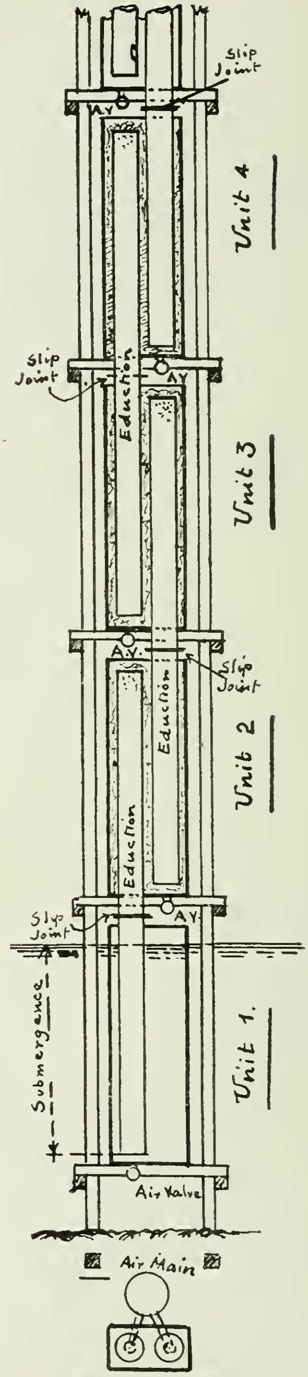
$$E = M \left(\frac{P_0}{P_1}\right)^{0.29}$$

when (M) is a numerical factor involving the altitude, and the mechanical efficiencies of compressor and pump.

The conclusion is that a low-pressure air plant is more efficient than a high-pressure one, or, in this particular case, that a low lift is more efficient than a high lift. And, therefore, if water is to be raised to a great height, the idea naturally occurs of cutting this up into a number of shorter divisions, each supplying water to the next one above. This has been suggested as a means of adapting the air-lift to mining work, each division being made longer than the one below, and a great height could thus be reached with a limited number of successive steps, the air pressure increasing from one to another.

A more satisfactory result is obtained by making the subdivisions of equal lengths. The pump column is then formed of a series of equal sections, or units, placed end to end, the air main running alongside of them, and a numerical illustration will give a clear idea of that arrangement and of its results. It will only be mentioned at this time that all the elements of an air-lift of that type can be determined with the same degree of accuracy as the details of an elaborate plunger or centrifugal pump. The figures here given are purposely approximate.

We will assume that 2000 gal. of water is to be raised per minute to a vertical height of 1424 ft. Were we to pump water against 1424-ft. head the pressure per square inch at



LOW PRESSURE COMPOUND AIR LIFT.

the foot of the delivery pipe would be about 640 lb.; a displacer would have to use compressed air at that pressure and even somewhat higher. The total lift of 1424 ft. will be divided into 100 equal units. Each unit, see sketch, consists of a tank, open at its upper end, and which may be of rectangular cross-section. A vertical eduction pipe is suspended in that tank with its open lower end a few inches above the bottom. Directly under it is the compressed-air nozzle, connected by a branch pipe to the air main. The lower unit is connected with the water-supply, which maintains into it a depth of 11.1 ft. The eduction pipe passes through the bottom of the second unit, and has its open upper end 11.1 ft. above that bottom; it is therefore a plain straight pipe open at both ends. The same arrangement is repeated in each unit; that is, each has a separate air jet and an eduction pipe rising to the top of the next. Each unit therefore consists of a rectangular tank, open at the top, and containing two parallel eduction pipes, one for its supply, the other for the discharge.

This being understood, the pump is ready to start, and air is turned on in the lower unit. As the head of water is 11.1 ft., a pressure of 5 lb. per square inch is sufficient. The emulsion of air and water rises up the eduction pipe and overflows into the second tank; the air, completely expanded, escapes in the shaft, while the water fills the space in the second tank not occupied by the eduction pipes. This water is picked up by air jet No. 2 and sent into the third unit, and so on, the same process being repeated through all the successive units to the top. An initial submergence of 11.1 ft. and an air pressure of 5 lb. gauge are all the requisites of the total lift; in the same locality, and with the same type of outfit, they would answer equally well for any other value of that lift.

Especial attention is called to the following points:

1. Since the units are all of equal length, this "low-pressure" arrangement consists in splitting up the entire lift into a series of shorter ones with a theoretic submergence of 50 per cent., the total efficiency being obviously the same as in each independent unit, regardless of their number. Whatever the total lift is, the submergence need not be more than the depth of the water in the first unit of the series.

2. The low air-pressure can readily be obtained from centrifugal blowers; this means a great reduction in first cost and maintenance of air-compressing outfit.

3. Whatever be the total lift in the same locality, at no portion of it are the air or water pipes to resist more than 5 lb. pressure to the square inch. Wood stave pipes or rectangular ducts are therefore quite acceptable, so that the pump can be built on the spot and kept in repair with local resources.

4. Each eduction pipe is cut off between two successive units, and a slip joint is used for connection. Any unit can therefore be detached from or attached to the line without disturbing the rest. These units, being identical, may be kept in readiness; any one of them may be placed at any point along the line.

5. In any specific case, the unit intended to form the pump column (and which is quite comparable to a link in a chain) is designed to perform a certain duty; that is, to raise a certain volume of water, at a certain altitude and mean temperature, and with a certain air-pressure. The volumetric ratio of free air to water is thus determined, and such a unit will fit a 60-ft. lift or a 6000-ft. lift equally well, be it in a mine shaft or in crossing a range of mountains. A change in one of the above elements in the design of the unit influences the others to an extent that can be determined. The simplicity and cheapness of construction make alterations in shape easily practicable.

6. At starting time, all the units are empty except the lower one, and each one is connected to the air main, so that, when air is turned on, it would blow off and be wasted all along the line. It is therefore necessary to provide each unit with an air valve automatically closed and thrown open when water reaches the submergence level in that unit. These valves are all identical and interchangeable, they are of simple design, entirely automatic, and they can be removed and replaced in a moment.

7. The pump requires no foundation, being suspended by cables during the unwatering period, and each unit is supported by the shaft timbers when stationary. The details of

its handling deserve and have received special attention.

8. At an assumed altitude of 4050 ft., each unit in the case at hand consumes 500 cu. ft. of free air per minute, making the capacity of the air-compressing plant 50,000 cu. ft. per minute, a figure by no means abnormal with centrifugal blowers. Here appears a unique feature of this type of pump, inasmuch as these 50,000 cu. ft. of air are discharged every minute into the shaft, where they create a powerful draft; this can readily be utilized for ventilation, either by suction up the shaft or by establishing a down draft, and this duty is performed at no additional expense. This twofold service of the air for drainage and ventilation, with the motive power placed in safety, introduces in the equipment of a mine a unique and additional element of economy. The pump will, of course, operate under water, in spite of the low air-pressure, because the first "active" unit is always the one nearest the surface, those below it (as they might be in case of sudden flooding of the shaft) are "dead" and inoperative, so that the work of the air-compressors is always measured by the actual lift.

These remarks, it is hoped, may suffice to draw attention to a system of mine pumping which escapes most of the objections mentioned against the familiar types of station plants. It does not involve any but simple, well known, and tried principles of action, and yet, it presents some practical and economical advantages of its own. It is not claimed, nor is it true, that the low-pressure lift should in all cases supersede any other types of pump; it has been worked out, and it is specifically intended for high lifts and large volumes of water; and when unwatering and draining a deep mine, it can accomplish some work which a pump of the usual design cannot do economically. It is very much cheaper in first cost than its equivalent in capacity, and it can be repaired with local resources and labor without resorting to a well equipped and too often distant machine-shop.—*Mining and Scientific Press.*

HOW TO LIGHT A FUSE

"The easiest thing in the world," you say, "just strike a match, hold it to the end of the fuse, and light it. That's all there is to it." But it isn't. Like many other simple operations, there are many ways of performing it, and it fills an experienced blaster with amusement to see a beginner use up about a box of matches trying to light one fuse. One way, about the slowest and most uncertain, is to strike a match and hold it so that the flame comes in contact with the end of the fuse. Theoretically, the powder in the fuse should light at once as soon as the flame strike it, but practically and actually it generally doesn't until the hemp, cotton or jute composing the wrappings of the powder core catch fire and the glowing threads ignite the powder. It is almost impossible to hold a match flame under a piece of fuse in the open air as the slightest breath of wind will blow it out.

Another way, says the Dupont Magazine, is to split the end of the fuse lengthwise, open up the powder core exposing the powder, and put the flaming match into the powder. This is all right, providing you have a sharp knife, a good eye and a steady nerve, but unless you have all these you will either cut your finger, or in your hurry to light up and "light out," you will shake the loose powder out, so that the fuse won't light.

The proper way to light a split end fuse is to place the end on a stone, block, or some other dry, solid object, and slit it through the powder core but no further. Open up the end and apply a match, or better still, the glowing end of a "punk" stick, such as the children use on the Fourth of July, or a dry cotton window cord, directly on the exposed powder. This latter method is about the best way when a large number of shots are to be fired as in block hole or mudcap shooting in quarries or railroad work.

About the best way to light one fuse with a match is to cut off the exposed end to get a dry, clean portion of the powder core exposed, and take a box of safety matches and hold the fuse and the match box in the left hand in such a way that the end of the fuse lies alongside the composition of the match box and on the same plane. Now, strike the match on the composition and instantly, before the head of the match gets fairly ablaze, put the match head directly on the center of the fuse. If the match head is not too small (the larger it is the better), it will infallibly light the fuse. This takes a little practice, but it is worth it to be able to quickly and safety light the fuse every time, and being able to do it with neatness and dispatch shows that you understand your business.

COMPRESSED AIR
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EVERYTHING PNEUMATIC
Established 1896

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COMPRESSED AIR STORAGE IN ROCK

On another page of our present issue is given an interesting account of the utilization of an abandoned mine drift for service as a compressed air receiver. This is by no means a novelty as we have more than once previously described such an achievement. It is rather to be wondered at that there are not more of these rock air receivers. In many, if not in most mines there must be similar abandoned drifts or sections of tunnel which might be appropriated. In mines where air is likely to be used for a considerable time in the future it might even be worth while to excavate a special cavity in new rock for air receiver service. With concrete and the applications of it as at present developed, and with suitable water proof—which should be also air proof—paints for the interior there should be no difficulty about making a receiver almost absolutely air-tight.

The rock receiver now described has a capacity probably equal to that of twenty steel receivers of familiar size, and the ability to store compressed air in such volume must be a satisfaction to a mine engineer. According to the description given, however, the receiver has the one general objection that it will not maintain a constant full pressure, but will allow an instant and continuous drop when the air consumption exceeds the compressor output, which puts all the air operated tools and machinery at an immediate disadvantage, with actual stoppage imminent. No matter how large the capacity of an air receiver it fails in its most important function if it does not maintain a constant pressure as long as it is operative at all.

Our columns have already called attention to the device which makes this easily possible. The arrangement is extremely simple, it is self-evidently practicable without the necessity for any experimenting, and it has been magnificently demonstrated at the Anaconda Copper mines, as we have previously recorded.

In connection with the rock receiver now spoken of, if there had been in the neighborhood another cavity in the rock, or any open receptacle for a body of water sufficient to entirely fill the receiver, at an elevation of say 200 ft. above it, it then would have been only necessary to connect this water supply with the bottom of the air receiver by a pipe which would permit an unobstructed flow of the water back and forth. Then if the air pipes, both inlet and discharge, were connected with the top of the receiver the arrangement would be complete. The pressure of the air would be constantly maintained above 85 lb. gage, by the pressure of the water until all the air was used out of the receiver. If the compressor was delivering more air than was being used the water would be driven back up into its tank but the air pressure would be maintained. It should not be necessary to remind our readers that the contact of the air with the water in this way would not add to the vapor content of the air, a fact which has been presented in our pages in various forms.

SURVIVAL OF THE FITTEST IN ROCK DRILL PRACTICE

The following is a brief extract from a valuable article by H. A. Guess entitled, "Mining in Southeastern Missouri Lead District," in the Transactions of the American Institute of Mining Engineers:

Less than 5 per cent. of the drills of the district are now run with two men, and it is probable that within another year nothing but one man drills will be in use. The type first adopted by those companies was the Sullivan U. S. 2.25 in. Within the past year, however, faster cutting drills than even the 2.25-in. Sullivan have been sought, and as a result one company has adopted water Leyners throughout, while two other companies are using the Ingersoll C-110 2.75-in. Butterfly-valve drill for a large part of their work. Attention has also been given of late to the large amount of time consumed particularly in tripod work in setting up, even with the one-man drill, and several of the companies are therefore beginning now to use hammer drills of the self-rotating type for down holes and even for lifters. These hammer drills for holes of not over 8-ft. depth will drill fully as fast as piston drills and no time is consumed in setting up, while the air consumption is only about one-half that of a 2.75-in. piston drill.

Steel is 1-in. octagon, solid, except for the Leyners, while for the hammer drills ⅞-in. hollow steel is used. The sets are of 2-ft. range from 2 to 12 ft. for piston drills and 2 to 10 ft. for hammer drills. Machine sharpening is quite general throughout the district, using either the "Z" bit or the + bit, and for the hammers a 6-star bit.

Consumption of air and of powder has been lessened by the contract system, as more skill is used in placing holes and therefore more tonnage is broken per linear foot of hole. Approximately 29 ft. of holes are drilled per shift per single machine, and approximately 1 ton is broken per foot of hole.

Power costs, as compressed air for drilling, are approximately 5 cts. per ton, and explosives 8 cts. Air is distributed to the drills at about 80-lb. pressure.

GAS ENGINE DRIVES

The Federal Glass Company, Columbus, Ohio, have recently bought from The C. & G. Cooper Company, Mt. Vernon, Ohio, a heavy duty Gas Engine Driven Air Compressing Unit. The Engine is of the Horizontal Single Tandem Double-acting type, having cylinders 19 inch bore, 24 inch stroke, and rated at 310 brake horse power. The Air Cylinder, which is of the Ingersoll-Rand Company's make, Hurricane inlet valve type, is direct coupled to the Engine on the front end of the Bed Plate. It is 26¼ inch diameter, with a capacity of 2100 cubic feet of free air per minute at 140 revolutions. This installation is a notable one, in that it marks a preference for the direct-coupled type of Gas Engine and Air Compressor, over the belted types, for highest efficiency, economy, and reliability of operation. The Cooper Company has also sold to The Charles Boldt Company, Cincinnati, for their new Huntington, W. Va., plant, two 550 brake horse power Gas Engines, each to be direct connected to a 350 K. W. Generator.

It becomes a matter for permanent record that on January 7, 1914, the Alexander La Valley, passed through the Panama Canal from the Atlantic to the Pacific under her own steam.

Of ninety thousand gas meters tested by the Inland Revenue department in different parts of Canada during the last year, 881 were found to be defective, and were rejected and condemned. Of this number, 235 were running slow, while 521 were running fast. It was found that 19,970 were a little fast, but 49,520 were a trifle slow, saving money for the consumer.

COMPRESSED AIR STARTERS

BY A. L. BRENNAN, JR.

During the experimental stages of self-starters, compressed air was used extensively and proved entirely reliable; but designers soon found that along practical lines it was adapted only to heavy power units. This was principally because on motor cars and boats the space available is often limited and since the first requirement of a mechanical or functional self-starter is compactness, this condition could not always be had when using a system that is not self-contained.

The component parts of a compressed-air system consist of a valve mechanism or distributor for controlling the air to the cylinders, suitable piping, air compressor, and storage tank for air. A tank holding air sufficient to start even a small multicylinder motor several times without recharging must be of fair size and consequently takes up considerable room. Some argue that a tank holding sufficient air to start the motor once is sufficient. This is poor practice, for, unless the tank is of sufficient volume to start the motor several times without recharging, any one of the several complications liable to take place when starting will render the self-starter inoperative. Little difficulty is encountered when installing this type of self-starter in stationary plants for the room required for suitable storage tanks is usually a secondary consideration.

The first cost of a compressed-air system is usually low and the operating and maintenance cost is small; also it requires little attention. In regard to the correct installation of such a system the following suggestion will be found of value.

Instead of using one large tank for the storage of the compressed air, two tanks should be used, one large and one small, fitted with suitable piping and valves to regulate the admission and release of air from either or both tanks. This will allow the compressor to feed air to either or both tanks and the small tank can be held for emergency purposes. A hand pump should be connected to the small tank, thus affording an auxiliary pumping system. If the joints are made up well with shellac and suitable valves are placed at the tanks, the air pressure should remain almost indefinitely.

Some air-starting mechanisms are controlled by a distributor which operates on the same principle as a timer which governs the flow of electricity to a spark plug. This method has proved entirely satisfactory and is to be found on several motors of various sizes. On other engines the direct-valve system is employed, the valves being controlled by a shaft which, when shifted, engages with the inlet compressed-air valve stems and causes the valve to open and admit compressed air to the cylinder last under compression, thus forcing the piston down, since both intake and exhaust valves are closed. The air valve is closed when the piston reaches the bottom center of the stroke and a similar set of operations take place in the next cylinder in the order of firing. The same operations take place in connection with a distributor starter, the only difference being that the air is admitted by the distributor "uncovering" instead of a valve opening.

Since both inlet and exhaust valves are closed during the admission of the compressed air, the efficiency of the mixture is not impaired for the reason that the air is not admitted to the cylinders until the pistons have passed the point of firing. The "direct valve" method appears to hold favor on large motors, although it must not be conceded from this that the disk distributing valve is not dependable.

The chief difficulty encountered with automatic air-starters is attributable to loss of pressure which in turn can be traced to poor check valves, faulty joints in the pipe line, distributor or valves leaking, worn or scored compressor cylinders, or the compressor piston or rings worn or broken.

AIR LEAKS.

Air leaks are usually easy to trace if undertaken in a systematic way. The writer has found an old shaving brush and a piece of shaving soap convenient for locating leaks of this nature. By painting the joints of the pipe line and other parts likely to leak with soap suds, a leak is easily detected and in fact very slight leaks can be found in this way which would otherwise go unnoticed. Care should be exercised when making up joints that the pipe fittings take hold for at least four or five threads. Shellac is undoubtedly the best medium to use for all air-line joints and should be applied evenly to both sets of threads and the joint set up firmly at once. Joints so treated will stand vibration without leaking.

Grinding is about the only positive remedy for a leaking valve. Valve grinding may be considered an art in itself, but the novice can get good results by following a few simple rules: Never attempt to grind a valve without first removing its "seating" spring for otherwise both the valve face and its seat are likely to be deeply scored. Never grind a valve by revolving it one way, but alternate, revolving the valve two or three times in one direction and then two or three times in the opposite direction. When changing the direction of rotation, lift the valve from its seat, turn a quarter and again seat, this will cause other particles of the abrasive to cut and prevent scoring or cutting in one place. Never use a dry abrasive except the very fine powders for finishing. Grinding is greatly facilitated by playing a spring under the valve head that will cause the valve to leave its seat when relieved of the pressure exerted when grinding. The valve should be ground against its seat until both have a bright even surface which will insure an air-tight union.

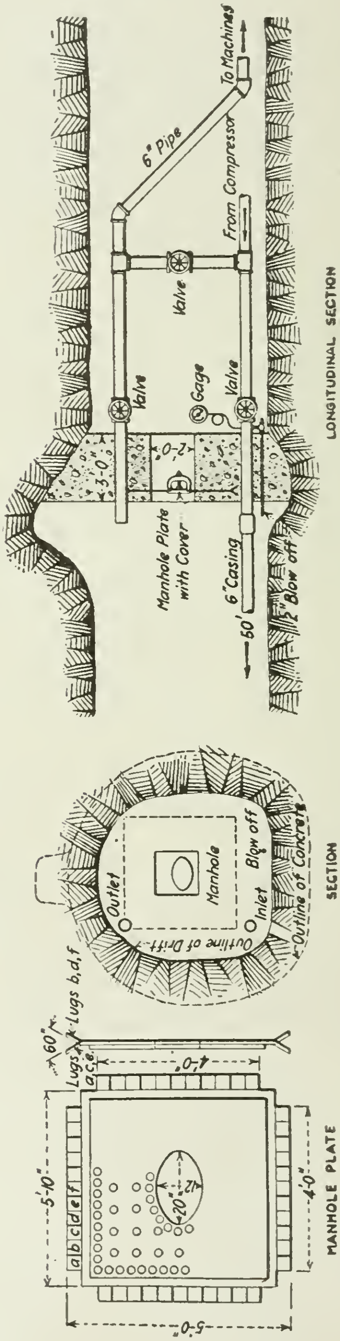
Starting troubles which prevent a gas engine from picking up its cycle when hand cranking is employed will likewise result in a non-start of motors fitted with self-cranking devices, therefore, if a motor is turned over by an auxiliary means and does not start within thirty seconds, this is, usually, a positive indication of existing trouble.—*Power.*

ROCK DRIFT FOR AIR RECEIVER

BY L. D. DAVENPORT.*

Compressed air for the hoist and the machine drills at the Ernestine mine, Mogollon, N. M., is furnished by two Ingersoll-Rand machines. The air is conveyed from the compressors at the power plant, across the canon and into the mine to the receiver by a 6-in. pipe line.

The air receiver was formed by placing a concrete bulkhead 3 ft. in thickness in an unusual crosscut in the brown andesite foot wall. This was built against a beveled recess cut in the rock. The crosscut thus bulkheaded is 109 ft. long and has an average cross-section of 42.7 sq. ft., giving a storage capacity



ROCK DRIFT AIR RECEIVER.

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*Engineer, Oliver Iron Mining Co., Eveleth, Minn.

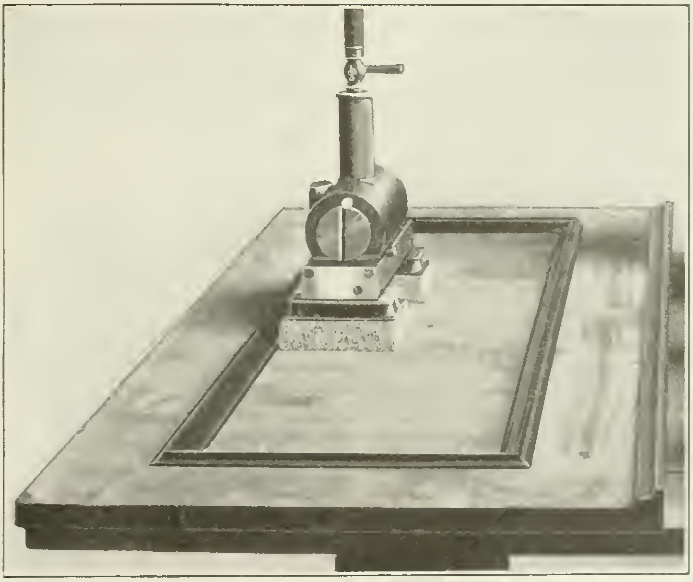
of 4654 cu. ft. A manhole plate, fitted with a cover, was set in the concrete 6 in. from the inside face of the bulkhead as shown.

The 6-in. line from the compressors passes through the bulkhead near the bottom of the crosscut and 6-in. casing pipe extends this line about 50 ft. beyond the bulkhead inside the receiver. Air is taken out near the top of the crosscut through another 6-in. line, which extends just through the bulkhead.

A cross-connection and the necessary valves were provided so that the receiver may be cut out if it is desired to remove the manhole cover. A 2-in. blow-off close to the bottom of the drift allows any water collecting in the receiver to be removed.

A 1:3:5 mixture was used in the bulkhead and the structure was reinforced with old 10-in. rails, machine screws and other scrap. Sand was screened from the creek bed and packed on burros to the mine dump. The rock used was shot from the rhyolite hanging wall near the receiver. The cement, like the manhole plate, was freighted 90 miles overland from the railroad.

The manhole plate was made of two ½-in. boiler plates riveted solidly together. The larger plate is 5 ft. square and has its edges cut back to form lugs 4x4 in., as shown, which were bent out alternately in opposite directions to anchor in the concrete. The smaller plate is 4x4 ft. The opening in the concrete is 2x2 ft., so that the plate had sufficient bearing in the concrete.—*Eng. and Min. Journal.*



A PNEUMATIC FURNITURE RUBBING MACHINE

The halftone shows a pneumatic tool made by the Rockford Tool Company, Rockford, Ill., which has proved itself an immediate boon to furniture manufacturers. It is used for rubbing and polishing flat surfaces of wood, thereby relieving the worker from one of the most tedious and tiring of operations, and doing the work two or three times as fast, with a proportionate saving in cost.

The machine is air actuated, using the air at the ordinary working pressure for pneumatic tools. The rubbing blocks move back and forth lengthwise of the machine some 900 times a minute, and the rubbers are moved by hand all over the surface to be finished. Pumice or other stone with water is thrown on to the surface to be rubbed, the same as when rubbing by hand. Then the machine is slowly moved across the surface, first to and from the operator, which motion keeps the water and pumice between the felts and prevents the varnish from heating and picking up.

By putting a little pressure on the machine the first time across it will more quickly cut the surface, and after an operator has used the machine for some little time he can very quickly tell when the work is done. The finish is superior to that produced by hand rubbing, as it is much more uniform. The machine is very handy for sunken panels, and works into all square corners. The machine makes another demand for the air compressor installation which is now practically indispensable in any up to date industry.

NOTES

An interesting article by Claude T. Rice, describing the Mitchell Dust Catcher for Stope Drills, presented in our February issue, should have been credited to *Mining and Engineering World,* in which it first appeared.

The hydraulic plant situated on the Lontsch River in Switzerland is now using what is claimed to be the largest Pelton wheel in Europe, the wheel being of 15,000 horse-power. In the same station there are already six Pelton wheels of 6,500 horse-power, so that the addition of this latest wheel brings the output of the Lontsch plant up to 54,000 horse-power and makes it one of the largest plants in Switzerland.

For the most effective ventilation it is most important that the air be kept in motion. Merely changing the air is not enough. Workmen will be comfortable in a warm shop if a perceptible breeze can be felt. It is a mistake to design a shop, especially a blacksmith shop, with the window openings six or seven feet above the floor. The men below do not feel any breeze and the evaporation of perspiration is slow.

The salary of Alfred Craven, chief engineer of the Public Service Commission, First District, New York City, has been raised from $15,000 to $20,000 per annum, making his salary the highest of all the engineers in the service of New York City or the State. In the capacity of chief engineer of the commission Mr. Craven has charge of all the work of the dual subway and transit system now under construction, involving the expenditure of $167,000,000.

It is reported that construction will soon be begun of a railway bridge connecting Rugen, an island in the Baltic Sea, almost due north of Berlin with the mainland of Germany. This bridge when completed will be one of the longest, if not the longest, in the world, exceeding even that over the Hwang ho, which is 10,740 ft. long. The cost of this great engineering work is not expected to amount to much more than $5,000,000, which will be less than a third of the cost of the Forth bridge.

It is stated that the first electrical plant to relieve the Arctic darkness will be erected at the Episcopal Mission at Point Hope. It will be designed, built and equipped by Dr. W. E. Temple, head of the electrical engineering department of the University of Pennsylvania. The site on which the plant will be erected will be 100 miles north of the Arctic circle. A huge windmill will be the prime mover, as the velocity of the wind at Point Hope is said to be rarely less than twenty miles an hour, but an auxiliary petrol motor is to be installed.

A pneumatic auger for removing timber has been tried with success at the Central Mine, at Broken Hill, Australia ("Proc." Aust. I. M. E., No. 10, 1913). Under the conditions of work it becomes necessary to drive new crosscuts over the old and the removal of the old timbering has been always a source of delay and expense, especially as neither an ax nor a saw could be used to advantage. Experiment with the Ingersoll-Rand augers was successful and two are in constant use. A plugger drill with a wide chisel blade was tried with fair succe*s*s, but was less comfortable to use.

Pneumatic methods for finding flaws in rock indicate whether or not the rock is pervious, but they do not locate the seams. An elaboration of this method is to attach rubber washers to a mouthpiece and by means of them to close off a small part of the hole and thus locate possible seams. This procedure, however, is tedious, and a method used near Augusta, Ga., for the investigation of the foundation for the dam of a hydroelectric project is claimed to be more economical. Here test holes were drilled into the granite—which was the prevailing rock formation—and dye was forced into the holes. In subsequent core-borings the color showed where flaws existed.

There is a great difference between Mexican revolutions and South African strikes. In a Mexican revolution every effort is made to preserve the mines from injury, and only to a limited extent is the labor supply affected. In a Transvaal strike, on the contrary, every effort is made to injure the mines and to close them down. On the whole, we prefer a Mexican revolution to a Transvaal strike! If the Mexican rebels and their enemies were to act towards the mines as the Transvaal strikers desired to do on the Rand last July, and again last week, the mines might come almost under Shakespeare's definition of "the baseless fabric of a vision," for not a "wrack" would be left behind.—*Mining World, London.*

The oil business and mining often are spoken of as twin industries, but over in Scotland this really is the case. There are no wells in the Scottish field, the oil is not even fluid; it is in a shale formation. This shale is almost as black as coal, and lies at a depth of about 400 ft. below the earth's surface. The oil shale is mined just as coal is mined, the rock is crushed into small pieces in crushing works similar to coal breakers, and the crude oil is squeezed out of the small pieces of shale much as water is squeezed out of a sponge. One ton of shale yields an average of 14 gal. of oil. Scottish oil goes through four different processes of acid distillation. The oil field in Scotland lies between Glasgow and Edinburgh, known as the West Calder field, and the deposits of oil-producing shale are said to be practically inexhaustible.

A system of tunnel canals is proposed for construction between Christiania and Lake Oieren in Norway. The lake is 325 ft. above sea level and is separated from the sea by a mountain 525 ft. high. It is proposed to construct a level tunnel 9⅓ miles long from the north end of Lake Oieren to Lake Ostensjo, from which another tunnel 2 miles long would run to the Bakkelags height, whence four deep locks would lead down to the Christiania fjord. The long tunnel canal would be 30 ft. wide and 16½ ft. deep. The variations of water level in Lake Oieren, amounting to as much as 10 ft., would necessitate a regulating lock at the entrance to the main tunnel. Lake Ostensjo is 13 ft. higher than Lake Oieren and would have to be lowered accordingly. The locks at the Bakkelags heights would be 200 ft. long and 26 ft. wide, with a fall for each of 82 ft. The cost is about $5,000,000.

Work on the pioneer bore which is the preliminary step in the construction of the double-track tunnel under Rogers Pass, B. C., for the Canadian Pacific Railway has advanced 850 ft. into the mountain from the east portal. On the morning of Jan. 28 blasts were fired at the heading on this end, and at 2 p. m. workmen were sent in to resume drilling operations. They met with foul air caused by powder gases, and attempted a hasty retreat, some of the men helping others who were less able to escape. At the tunnel entrance it was found that six men were missing and a rescue party was quickly organized. Conditions within were so bad, however, that one by one five of the rescue party were carried out unconscious, and it was only by dint of heroic work, it is said, that those who were overcome were finally brought out. All but two, however, were finally revived.

The alloy Tantiron is a special grade of cast iron made in England and very high in silicon. It has special resistance to corrosion and is therefore recommended for use in pipes and fittings in chemical works and other places where acid attack is the chief consideration. It is said to be very brittle and so only suitable for small castings.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

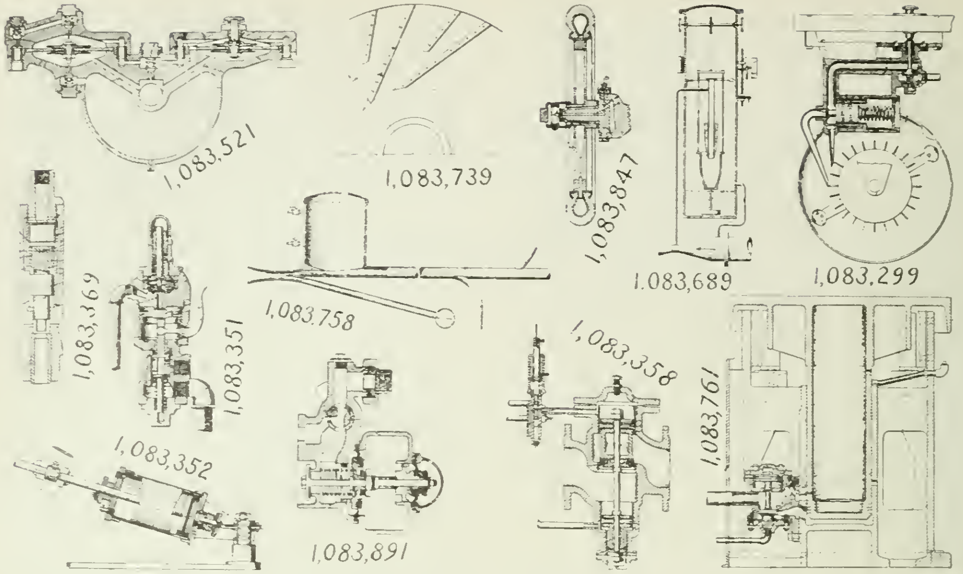
JANUARY 6.

1,083,299. FLUID-ACTUATED ALARM. George R. W. Roberts and Harry Hoopes Seely, Alameda, Cal.

1,083,351. SAFETY DEVICE FOR BRAKES. Sidney G. Down, Chicago, Ill.

1,083,352. AUTOMATIC CLUTCH-LEVER REGULATOR. William E. Eastman, Boston, Mass.

2. A clutch lever regulator comprising an oscillating cylinder; a piston therein having a piston rod attached to the lever of said regulator; a valve in the foot of said cylinder, normally closed, and means, induced by the oscillation of the cylinder, to open and close said valve



Pneumatic Patents January 6.

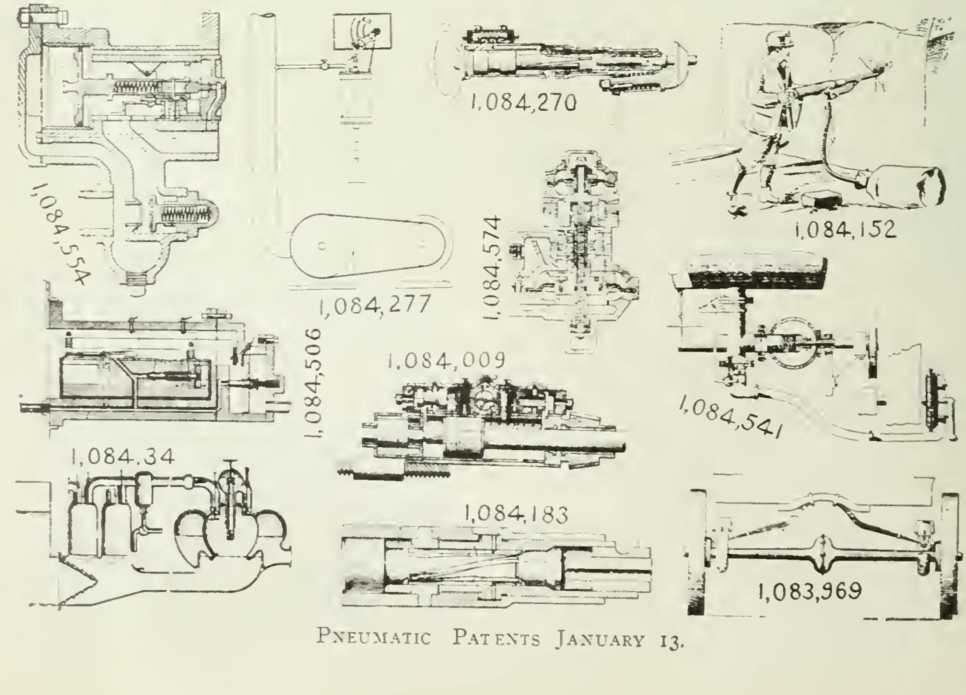
momentarily before the end of the inward stroke of the piston to permit enough air to escape to allow the piston to have a differential inward motion.

1,083,358. VALVE FOR CONTROLLING FLUID-PRESSURE. Robert Freer and Samuel Greer, Providence, R. I.

1,083,369. PNEUMATIC TOOL. Henry E. Le Gendre, Creskill, N. J.

1,083,521. PNEUMATIC BRAKE. Francois Jules Chapsal and Alfred Louis Emile Saillot, Paris, France.

1. In a pneumatic braking system for railway cars and the like, the combination with the train pipe and the local branch of each car, of an accelerator disposed in said branch, said accelerator comprising a casing, diaphragms disposed therein subject on their one face to the pressure



Pneumatic Patents January 13.

of the train pipe, and valve mechanism controlled by said diaphragms to control the passage of air to and from the local branch.

1,083,689. FLUID-METER. JOHN W. LEDOUX, Swarthmore, Pa.

1,083,739. CENTRIFUGAL PUMP AND COMPRESSOR OR THE LIKE. HANS GUYER, Zurich, Switzerland.

1,083,758. EXHAUST APPARATUS FOR MINES. BALINT PUSKAS, Windber, Pa.

1,083,761. VALVE FOR JARRING-MACHINES. ROBERT FRANKLIN RINGLE, Zelienople, Pa.

1,083,847. SYSTEM FOR INFLATING PNEUMATIC TIRES. CHARLES P. McDOWELL, WINLOCK, and RICHARD H. EASTER, Elma, Wash.

1,083,891. ACCELERATOR FOR AIR-BRAKES. JOSEPH DE LIPKOWSKI, Paris, France.

JANUARY 13.

1,083,969-70. PNEUMATIC SUSPENSION DEVICE FOR VEHICLES. JOHN WILLIAMSON, New York, N. Y.

1,084,009. FLUID-PRESSURE DRILL. JOHN ALLEN HEANY, Washington, D. C.

1,084,152. DUST-REMOVER FOR ROCK-DRILLS. VILHELM PHILIP KESSEL, San Francisco, Cal.

1,084,183. ROTATING MEANS FOR ROCK-DRILLS. DANIEL S. WAUGH, Denver, Colo.

1,084,270. HAMMER-DRILL. CHARLES C. HANSEN, Easton, Pa.

1,084,277. AUTOMATIC PRESSURE-SWITCH CONTROLLER. CHESTER S. JENNINGS, Boston, Mass.

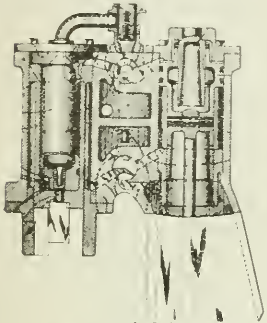
1,084,322. AIR-PUMPING APPARATUS. JOHN J. EVERSON, Newton, Mass.

1,084,340-1. METHOD OF UTILIZING AN EXPANSIVE FORCE. HERBERT ALFRED HUMPHREY, London, England.

1,084,463. MEANS FOR STOPPING TRAINS. WILLIAM T. B. McDONALD, Granby, Quebec, Canada.

1,084,503. AUTOMATIC BRAKE-CONTROLLING DEVICE. GEORGE C. SWEET, U. S. Navy.

1,084,506. ELECTRICALLY-OPERATED AIR-BRAKE. HARRY L. TOOKER, Winslow, Ariz.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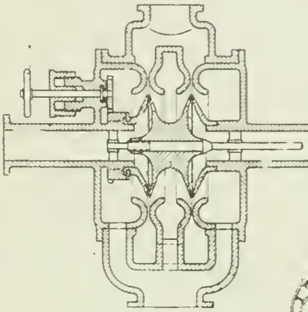
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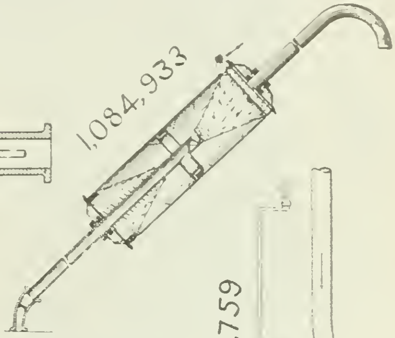
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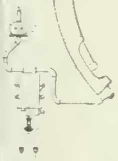
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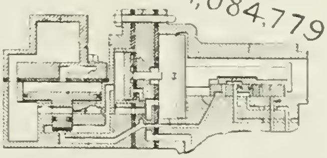
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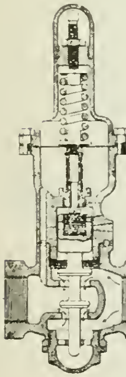
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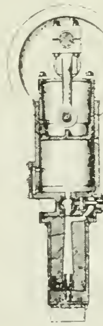
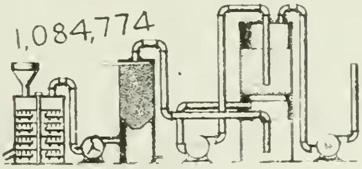
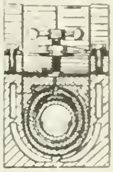

1,084,689


1,084,774


1,084,895

PNEUMATIC PATENTS JANUARY 20.

1,083,971. AIR-BRAKE. GUSTAVE B. WOLF, Smithville, Tex.

1,083,988. PROCESS OF SEPARATION OF THE CONSTITUENTS OF GASEOUS MIXTURES. GEORGE CLAUDE, Paris, France.

1. A method of separation by means of liquefaction compressed and cooled air into liquids rich in oxygen and nitrogen, respectively, consisting in passing it through an upwardly conducting laterally confined space, and then in continuation through a downwardly conducting confined space, and maintaining the downwardly conducting space, and the upper part of the upwardly conducting space at a lower temperature than the lower part of the upwardly conducting space and sufficiently low to cause the liquefaction in those parts of the nitrogen of the gaseous mixture.

1,084,541. EXPLOSIVE-ENGINE-STARTING DEVICE. FREDERICK C. DOODY, St. Onge, S. D.

The combination of air compressing mechanism, a controlling cylinder in communication therewith, a driving wheel, a tubular shaft on which the driving wheel is mounted for rotation, a piston in the controlling cylinder actuated by pressure in one direction, a spring to move the piston in the reverse direction on a diminution of pressure, a rod connected to the piston and extending through the tubular shaft, a clutch member connected to the piston rod and arranged to engage and disengage the driving wheel, and a gear on the tubular shaft connected to and actuating the air compressing mechanism.

1,084,574. COMPRESSED AIR BRAKE. JOSEPH DE LIPKOWSKI, Paris, France.

JANUARY 20.

1,084,689. POWER-HAMMER. Ralph E. Bates, Philadelphia. Pa.

1,084,707. FLUID-POWER HAMMER. John Nazel and Ralph E. Bates, Philadelphia, Pa.

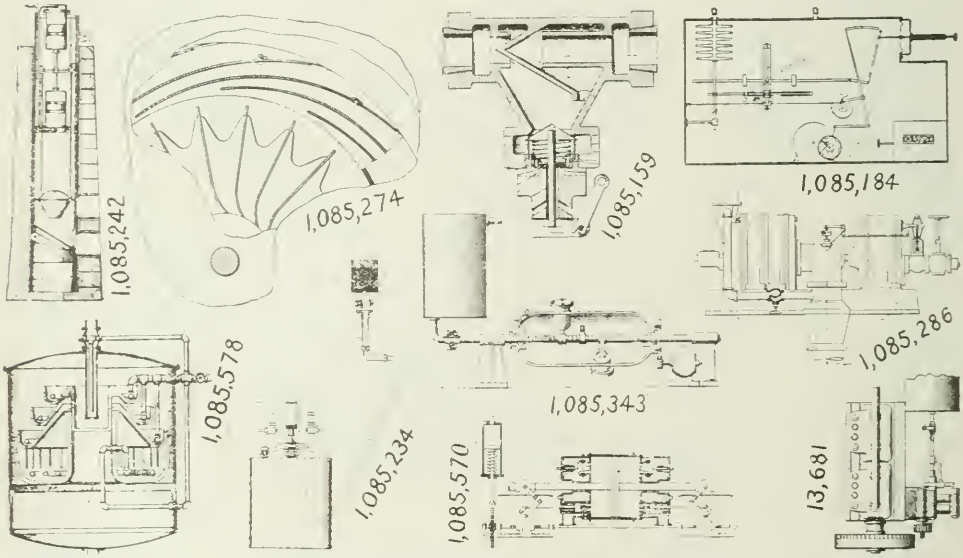
1,084,759. CARRIER - DESPATCH SYSTEM. Frederick L. Soule, Lowell, Mass.

1,084,774. METHOD OF OBTAINING NITROGEN AND MAKING COMPOUNDS THEREFROM. Thomas Leopold Willson and Maximillian Mattheus Haff, Ottawa, Ontario, Canada.

1. The process of obtaining nitrogen from the atmosphere which consists in burning sulfur in a confined body of air and passing the resultant gaseous mixture through a solution containing lime to form a bisulfite liquor and then passing the resultant gas over sulfurous de-oxidizing means.

1,084,779. AUTOMATIC FLUID-BRAKE. Louis H. Albers, Albany, N. Y.

1,084,895. PNEUMATIC - TIRE - CASING-REPAIR DEVICE. Joseph N. Newsom, St. Louis, Mo.



Pneumatic Patents January 27.

1,084,933. VACUUM-CLEANER. Edmund J. Feeny, Muncie, Ind.

1,084,940. PRESSURE-REDUCING VALVE. Frederick L. Jahn, Philadelphia, Pa.

1,084,955. AUTOMATIC AIR-BRAKE COUPLING. Dorcie R. Nugen, Auburn, Ind.

1,085,046. APPARATUS FOR COMPRESSING GASES AND VAPORS. Georg Holzapfel, Essen-on-the-Ruhr, Germany.

1,085,058. PNEUMATIC LOCK. John Clayton Messick, San Rafael, Cal.

JANUARY 27.

1,085,136. ELASTIC-FLUID TURBINE. Walter Kieser, Charlottenburg, Germany.

1,085,184. APPARATUS FOR INDICATING AND RECORDING THE FLOW OF FLUIDS. Thomas R. Weymouth, Oil City, Pa.

1,085,234. SELF-FEEDING PAINT-BRUSH. James Allan, Glasgow, Scotland.

1,085,242. WAVE-ACTUATED AIR-COMPRESSOR. Samuel Caldwell, Oakland,, Cal.

1,085,274. DISCHARGE-VANES FOR CENTRIFUGAL COMPRESSORS. Louis C. Loewenstein, Lynn, Mass.

1,085,286. MEANS FOR PREVENTING SURGING IN CENTRIFUGAL COMPRESSORS. Sanford A. Moss, Lynn, Mass.

1. In combination, a centrifugal compressor which is subject to surging at light loads, a constant volume governor therefor, and a bypass for returning fluid to the intake pipe at a point between the governor and compressor whereby the compressor is always loaded to a value above the breakdown point, and all of the fluid entering the compressor acts on said governor.

1,085,343. POWER-TRANSMITTING MECHANISM. Oscar Keck, New York, N. Y.

1. In a mechanism of the character described, the combination with a support, of a shaft journaled in the support, a horizontally disposed receiving cylinder, loosely held upon the shaft, said cylinder being provided with an intake for the admission of a *fluid under pressure* and having a vent in one of its ends, an auxiliary cylinder provided in the wall of the receiving cylinder and arranged on an angle within said receiving cylinder, a piston movable within the auxiliary cylinder, a crank having one end pivotally connected to the piston and its other end rigidly fastened to the shaft, and means provided upon the receiving cylinder whereby said cylinder may be rotated by a suitable power.

1,085,570. UNLOADING DEVICE. Carl G. Sprado, Milwaukee, Wis.

1. The combination with a constant speed blowing engine cylinder having inlet and outlet ports, of a piston and piston rod, an auxiliary outlet valve, and a pinned link means for automatically reducing piston motion connecting the piston rod, the auxiliary valve, and the engine frame.

1,085,578. WATER-STERILIZING TANK. Siegfried Held, Chicago, Ill.

1,085,579. OZONE-GENERATOR. Siegfried Held, Chicago, Ill.

1. The combination with a tank having an inlet for water in its upper portion and an outlet therefore in its lower part, of a plurality of superimposed channeled members located in the tank and provided with means for the passage of water therefrom, and a separate perforated tubular member located in each of said channeled members and having communication with a *supply of ozonized air*.

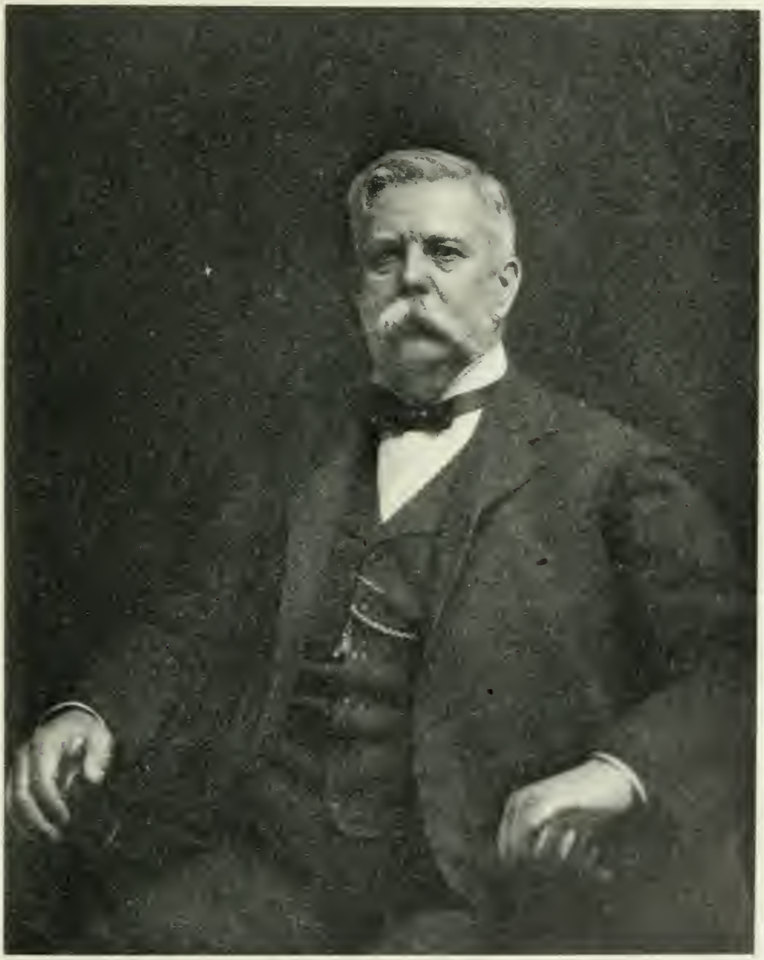
13,681 (Reissue). ENGINE-STARTER. William L. Stuller, Detroit, Mich.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XIX APRIL, 1914 No. 4



Geo. Westinghouse

GEORGE WESTINGHOUSE

One of the world's greatest and most successful inventors, an organizer of wide reaching industries, a maker of history not to be ignored in any broad view of human progress, has passed away. He will always be best known to all the world as the inventor of the air brake, and in that capacity he appeals especially to the readers of Compressed Air Magazine, but the reach of his activities embraced much more than that.

Mr. Westinghouse died in New York City March 12, of chronic heart disease, which began its manifestations fifteen months before. Through all his active and strenuous life he had never been critically ill before, and the sudden breaking of his health came as a great shock to his family and associates. He had not left his room for three months, and he was unconscious for three days before the end came.

We may not know what plans were left uncompleted, or what a prolonged life might have produced for the augmentation of mechanical means and methods and in the extension of engineering practice, but his record was already full of completed accomplishment.

But a brief and incomplete sketch of the career of Mr. Westinghouse can be given here. He was born at Central Bridge, Schoharie County, N. Y., Oct. 6, 1846. When he was ten years old the family moved to Schenectady, N. Y., where his father was for many years head of the Westinghouse Agricultural Works, and the son was thus given a mechanical impetus from the beginning. At the age of fifteen he had made a tolerably successful rotary engine. In June 1863, before he was seventeen, but he was six feet tall and weighed 180 pounds, he enlisted in the Twelfth New York Infantry. In November he joined the Sixteenth New York Cavalry, serving a year and being discharged a full corporal. A month later he was appointed a third assistant engineer in the navy, and he served in different ships to be honorably discharged at the close of the war.

He at once entered Union College taking the classical course, and his college record is unique. He did not graduate, but he was not dismissed for any fault. The President of the college frankly said to him: "You are wasting your time here. You are a faithful student, but our classical course is not likely to be of any service to you. You know as much of mathematics, if not more than we can teach you, and you have a genius for invention. The college work is holding you back from your absorbing interest. Continue as you are going and you will become a great engineer."

He took the wise president's advice and took out his first patent, which was for a re-railing frog. Returning from a visit to Albany he had been delayed by the derailing of a freight-train. He watched the futile efforts of the trainmen and at once devised the frog. With two other men who put up $5000 he started his first factory for the manufacture of the frogs, retaining the patents in his own name. The partners seized the business and without Westinghouse it soon failed. He soon after became a salesman for a steel casting company who took up the frog again and made it a success.

The same year what must be considered his life-work began. In one of his trips between Schenectady and Troy he came upon a bad train wreck, a head-on collision on a straight track. The danger had been seen by the engineers in good time but the hand brakes could not be set soon enough. In those days the engineer could only brake his engine, and a couple of toots of the whistle was the only signal to the brakemen on the cars, and they could only respond slowly, applying one brake at a time even when they realized the urgency of the danger.

This started the alert inventor upon a problem which we realize now was not a simple one which could be successfully solved by a single stroke of ingenuity. Various arrangements were thought of and some were tried without success: automatic brakes attached to the couplers, steam actuated brakes, but the right idea finally came to Mr. Westinghouse upon his reading of the success of the air actuated rock drill in the Mont Cenis tunnel. The first convincing test of the brake, not simply as a brake or as a car brake, but as a *train* brake was in 1868, and the first patent was dated April 13, 1869, the complete record of Mr. Westinghouse's personal patents amounting to over 300. The first road to adopt the brake was the Pan-handle. The Pennsylvania took it up and all the others followed with a rush.

Of the details of the air brake inventions the triple valve must be considered the most original and ingenious and the most important. This reduced the time for full application of the brakes on a ten car train from twenty-five seconds to eight seconds, or it reduced by nearly a quarter of a mile the distance in which a train at forty miles an hour could be stopped, but this was only the beginning.

Perhaps not less important was the development of the application of the brake on freight trains. In a string of fifty cars the full force of the brakes would not be applied to the rear cars in less than eighteen seconds, and this sometimes meant consequences almost as disastrous as a collision. Trains buckled and telescoped, broke couplings and drawbars. Mr. Westinghouse studied out the problem, and in the summer of 1887 he made modifications in the triple valve which allowed full application through long trains in two seconds. In October and November of that year a demonstration train made a triumphal tour of the country, and railroad men were amazed when they saw a loaded freight train, a third of a mile long and running at forty miles an hour, stopped smoothly in 581 feet.

The air brake pump, as it is familiarly designated, was another ingenious detail of the air brake equipment which had the rare merit of being perfectly adapted to the service for which it was designed. It has been kept up to date by successive improvements, and no other inventor has been able to supersede it. It reliably and automatically maintains the required pressure in the system without any looking after when out on the road, and if it is not as economical of steam as it should be, the steam used by it is often that which otherwise would be escaping more noisily by the safety valve.

The air brake pump has incidentally been one of the greatest and most efficient missionaries for the promotion of the general employment of compressed air for other purposes. Spare pumps are practically always available in railroad shops, and this has led railroad men into the habit of thinking compressed air, and of devising new and various ways of getting it to help them.

Mr. Westinghouse was well equipped with the push and the business faculty which too many inventors, unfortunately have lacked Retaining the control of his invention he undertook the entire manufacture of it and organized the Westinghouse Air Brake Company, establishing at Pittsburgh the business which became the nucleus of the many industries associated with his name. After the success of the air brake it came quite naturally in the way of the inventor to apply compressed air to the operating of switches and signals and from this grew the Union Switch and Signal Company.

This line of employment brought Mr. Westinghouse in close touch with electricity and he turned his helping brain to the quickening of the phenomenal developments then in progress. He was quick to see and to take advantage of some of the yet undeveloped possibilities. He devoted his energies to the utilization of the alternating current for lighting and for power transmission, and in this he had to meet and overcome fanatical opposition which went the length of trying to procure prohibition legislation.

In 1885 he acquired the patents of Gaulard & Gibbs and he personally devised apparatus and methods for the distribution and utilization of electric currents in a large way, besides which he gathered about him a group of men who were to become experts in the novel field thus opening to the world. He organized the electrical company which bears his name and undertook the development and manufacture of the induction motor, which made practical the utilization of the alternating current for power purposes.

Then still another line of opportunity found Mr. Westinghouse ready for it. Following the discovery of natural gas in the Pittsburgh region, he devised a system for controlling the flow and for conveying the gas over long distances through pipe lines. He took up the study of the gas engine, and for ten years conducted a series of exhaustive experiments in this line and then put into commercial use a gas engine of large power for electric generating and for rolling mill work.

Still again, Mr. Westinghouse introduced the Parsons steam-turbine into this country, adding developments and improvements of his own or carried out under his supervision. He also developed a special steam turbine for ship propulsion, co-operating with the late Rear-Admiral Geo. W. Melville and John H. Macalpine in their study of the problems associated with the driving of propellers at low speed by turbines of high speed.

It is quite unpracticable if not impossible for us to enumerate the inventions which Mr. Westinghouse personally made or those which his staff have brought out under his supervision. The latest seems to have been the pneumatic spring for automobiles, and of this it may be assumed that all the possibilities connected with its employment have not yet developed. As a result of his work and enterprise there grew up thirty corporations of which he was president, employing 50,000 men and $120,000,000 capital, with works at Wilmerding, East Pittsburgh, Swissvale and Trafford City, Pennsylvania; at Hamilton, Canada; London and Manchester, England; Havre, France; Vardo, Italy, and at Vienna and St. Petersburg.

Mr. Westinghouse made many visits to Europe. Not only had his fame spread over all the world but he won the friendship of the foremost men of his time and the high esteem of the engineering profession. He was decorated by the French Republic and by the sovereigns of Italy. He followed his friend Lord Kelvin as a recipient of the John Fritz medal. The Königliche Technische Hochschule of Berlin bestowed upon him the degree of Doctor of Engineering and his own Union College, from which he did not graduate, gave him the degree of Ph, D. Besides his Honorary membership in the American Society of Mechanical Engineers and his Presidency of the Society, Mr. Westinghouse was one of the two honorary members of the American Association for the Advancement of science and an honorary member also of the National Electric Light Association.

Mr. Westinghouse must be regarded not only as a successful but also as a fortunate inventor and man of affairs. He had from the beginning the fullest freedom to avail himself of his opportunities as they arose, and apparently had no family or other discouragements or hindrances. He was highly fortunate in his physical and mental endowment. He was fortunate in having secured without apparent special effort in that direction the pecuniary reward which so many fail to attain. He was fortunate in having secured the highest respect and esteem of them who knew him, and the world was fortunate in the life and work of a great man.

LOSSES TO THE NATION FROM MINE ACCIDENTS AND MINERAL WASTE*

There is no exact measure of the losses from mine accidents and mineral waste, but we may use an approximate measure. If the increasing rate of coal-mine fatalities during 1905, 1906, and 1907, the three years prior to the beginning of this work, had continued throughout the four subsequent years, since Congress authorized these mine-exposion investigations, the number of fatalities would have been at least 4,000 greater than they have actually been. At approximately the average compensation paid in fatal mine accidents of the past few years, this would represent a national loss of $12,000,000 in the four years. If it is remembered that for every fatal accident there are at least three to five serious non-fatal accidents, and twelve lesser accidents which incapacitate for one or more days, it will be seen that the actual national loss expressed in money value would have been much larger.

In mineral waste, the national loss is estimated to be not less than $1,000,000 a day. This loss for the most part is not such as may be considered as representing a deferred use of resources, but represents a total permanent loss of national wealth.

The mineral losses are considered as national losses for the reason that the mineral products of the country, becoming articles of interstate commerce, are used by the people of all the States quite regardless of their source. For the same reason, the cost of investigations looking to the prevention of these losses should not fall upon any one State; and if conducted by each of the States, the result would be extensive and unnecessary duplication of effort and expenditure. We cannot expect the individual operator to bear the cost of such investigations for the reason that waste prevention with him is a question of temporary profits, and his temporary profits, in many cases at least, are greater by virtue of his following wasteful methods. With both the community and the Nation the situation is often quite different, and they must safeguard their own permanent welfare.

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*From the third annual report of the National Bureau of Mines, Joseph A. Holmes, Director.

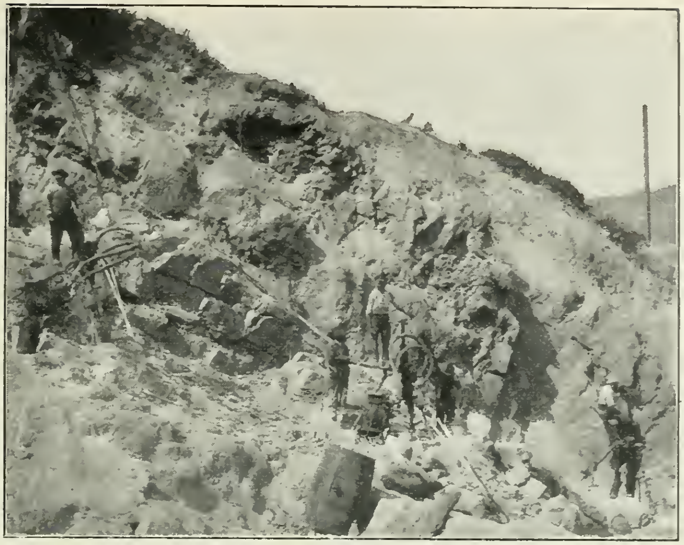

FIG. I. ELECTRIC AIR DRILLS AT PLEASANTVILLE, N. Y.

CONTRACTORS' PLANTS ON THE NEW YORK STATE BARGE CANAL

BY CHAS. A. HIRSCHBERG.

The State of New York has long been noted for its gigantic engineering projects, some of them, the Barge Canal, Catskill Aqueduct and Hudson River Tunnels, ranking among the first of the world's great engineering achievements, which in years to come will be recognized as monuments to the boundless effort and resourcefulness of the men who conceived them and those who had the courage and temerity to undertake their building. But aside from the credit due the engineer and builder, there is a coterie of designing engineers and manufacturers to whom a great deal of credit is due for the genius displayed in the design and supervision of the building of the various machinery that made the prosecution of these engineering undertakings a commercial and expeditious success.

This machinery has become a familiar sight to the big majority of people and, with the exception of certain special equipment which is mentioned later, is familiar to the man who has knowledge of general mining and quarrying methods and machinery. Briefly they may be divided into the following general classes:

Air Compressors.
Mounted Rock Drills.
Submarine Drills.
Deep-hole Drills.
Hand Hammer Drills.
Drill Sharpeners.
Channelers.

The air compressors may be subdivided into several minor groups according to the driving means employed: steam, belted power and direct-connected electric.

Among others may be mentioned the following air compressor installations on the Barge Canal: Arthur McMullen, Delta, N. Y., Class "A" steam driven type; Acme Engineering & Construction Co., Herkimer, N. Y., Class "AA-2" steam driven machines; Kinser Construction Co., Fort Edward, "Imperial" Type "X" steam driven; H. P. Burgard, Buffalo, N. Y., two-type "XB-2" belt driven compressors; Oswego Construction Co., Fulton, N. Y., Type "XB-2" belt driven; Larkin & Sangster, Lockport, N. Y., Class "PB-2" belt driven compressors; P. McGovern Co., Mechanicsville, N. Y., Class "NF-1" steam driven. While these represent but a few of the compressors in use, they will serve the purpose of this article, as it is the intention to touch on but one or two installations at any great length.

The Class "A" air compressor is of the single-stage air, straight line type, embodying rugged simplicity and high "all-around" economy. The steam valve gear is of the plain "D" slide type.

The Class "AA-2" air compressor has steam valves of the balanced adjustable cut-off type. The air end is of the most advanced type of two-stage construction, with a very large overhead intercooler and completely water-jacketed cylinders. This compressor is the recognized standard in straight line construction. It combines compound economy with the simplicity, compactness and "unit" quality of the plain, single, straight line type.

The "Imperial" Type "X" air compressor is of the duplex type. The air end is built either simple or compound. Inlet valves are of the well-known "Imperial" Corliss type and discharge of valves of the "Imperial Direct-Lift" pattern which insure the admission and discharge of a full cylinder of air at every stroke. The steam valves are of the Meyer cut-off type on large sizes and plain slide on small.

Class "NF-1" air compressor is ideal for the small contracting plant. It embodies every up-to-date improvement; dust-proof, enclosed construction, unusual simplicity, automatic splash lubrication, high speed and large capacity with minimum dimensions.

At Herkimer the Acme Engineering & Construction Co. have in use the plant formerly located on their contract at Vischer's Ferry. The installation at Vischer's Ferry was perhaps of especial interest because of its central location in relation to the contract as a whole.

All the engines and pumps at Vischer's Ferry were driven by compressed air, with the exception of one derrick. The plant consisted of two Ingersoll-Rand 24-inch steam, 26¼ and 16¼ air by 24-inch stroke two stage compressors, driven by steam furnished by five 100 H. P. boilers of the portable, return tubular type.

After being compressed to 100 pounds the air passed to a 5-foot by 18-foot vertical receiver, located just outside the building, from which point it was distributed to different parts of the contract. One air main leads to the machine shop where it operates a 20 H. P. engine driving the shop tools, also a 300-pound hammer and several forges.

A second line furnished air for a 9 by 10 Lidgerwood hoist on a traveling derrick with an independent swinging engine, a 5-inch plunger pump and a 12-inch direct-connected centrifugal pump, drills used in the excavation, etc.

A third line supplied the work in the main dam, in a similar manner also two revolving derricks located on an island.

A fourth line ran directly to the island and supplied air to several 10-ton cable engines, hoists, etc.

At dam 2, Crescent, was installed an Ingersoll-Rand belt-driven compressor with air cylinders 25¼ and 26¼ by 16-inch stroke, having a capacity of 1,205 cubic feet of free air

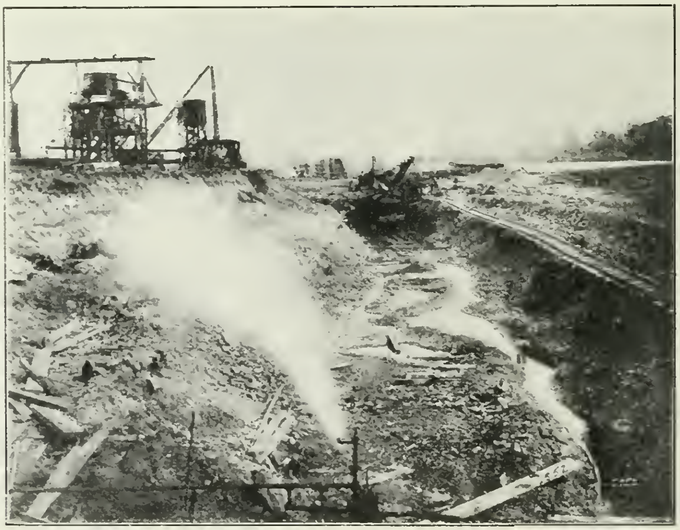

FIG. 2. DRILL WAGONS AT STILLWATER, N. Y.

per minute. This air was used for running hoists and drills at the quarry, several hoising engines at the canal and for machinery used for work in the river.

A great many Rock Drills have been used on the Barge Canal work of various types and sizes, such as the Sergeant F-24, E-24, the Butterfly C110 and the 5-F Temple-Ingersoll.

The Sergeant type of drill has long been a favorite with contractors owing to its rugged design, superior valve movement and rapid drilling qualities. It is recognized as the standard tripod drill. The distinguishing feature, its valve movement, is a combination of the independent air-thrown valve with the Tappet valve action, retaining the enhancing advantages of both valve types. This superior valve mechanism has been applied on a structure of the best design and materials, resulting in a drill, which for hard service is the most powerful, effective and reliable machine on the market.

The Butterfly "C110" type is a drill of 3¾ inch cylinder diameter, embodying the Butterfly valve, which is non-freezing and rapid moving, giving the machine a large drilling capacity. The cylinder and front head are made from "Irco" metal, the toughest, longest wearing mental ever employed in any rock drill. It is practically indestructible, and breakages are unknown. The Butterfly Drill is much lighter than the ordinary rock drill and yet will do more work.

Temple-Ingersoll Electric-Air Drills were used by F. A. Maselli, Rochester, N. Y., and by the contractors who succeeded Gilmour, Horton & Allen at Oswego. They were originally purchased by Gilmour, Horton & Allen when this portion of the canal was started.

This drill in general consists of two units, the drill proper and the pulsator. The drill itself resembles in appearance the ordinary compressed air drill, and is mounted on a tripod in the usual manner. The air for driving this drill is furnished by the pulsator which is electric motor driven, the air being supplied to alternate ends of the drill by means of a closed circuit between it and the pulsator. In this manner the air is used over and over again and advantage taken of its expansive properties. The air is never exhausted and what leakage occurs is provided for by a compensating valve on the pulsator, which automatically keeps the volume of air in the system constant.

Of the hand hammer drill class, two types, the Jackhamer BCR-430 and Butterfly BA-23 seem to have been the favorites, there being a great many in use all over the canal for breaking up boulders, trimming, etc. The latter is of the hand rota-

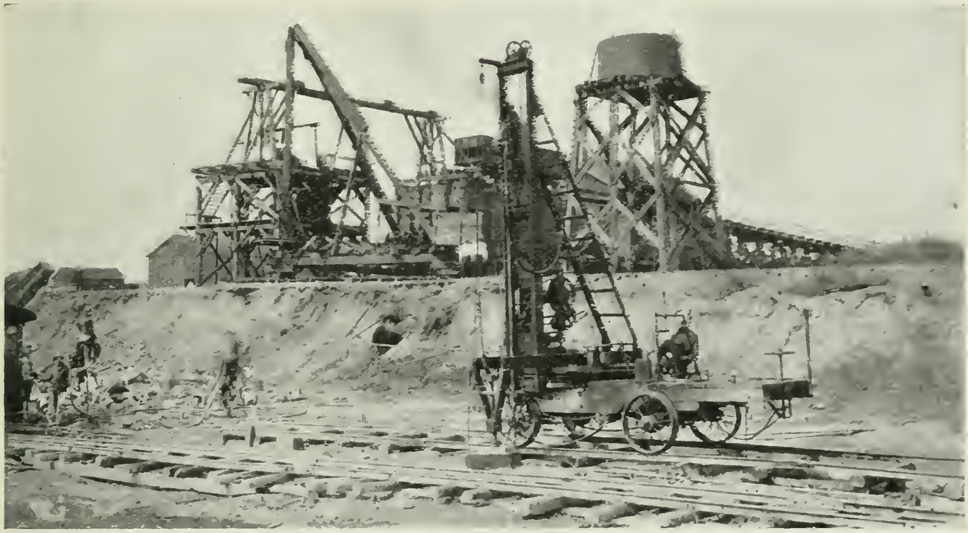

FIG. 3. TURNTABLE DRILL WAGON AHEAD OF STEAM SHOVEL.

ted type, weighing 43 pounds, capable of drilling a hole 5 or 6 feet deep.

The former (Jackhamer) is a self-rotating drill of remarkable drilling capacity that may be operated by steam or air. It is a great favorite owing to the self-rotating feature, as it does not fatigue the operator. In addition the Jackhamer is provided with a hole-cleaning device, which is simple and easy to manipulate. This hole-cleaning device, in conjunction with a steel holder that permits moving the steel up and down in the drill hole, enables the operator to keep the hole free from cuttings, steels are not stuck and as a result the percentage of working time is high. Both drills are provided with automatic lubricators.

Ingersoll-Rand H-8 steam track channelers are in use by the McDermott Co. (now being carried on by the Oswego Construction Co.) at Fulton, N. Y., and Lane Bros., Rochester, N. Y.

This channeler is a direct-acting, single-gang machine, marked by a massive strength and features of design which guarantee high economy, great power, reliability and large cutting capacity. It is designed for heavy work and deep cuts. Steam being used, it was equipped with an upright boiler.

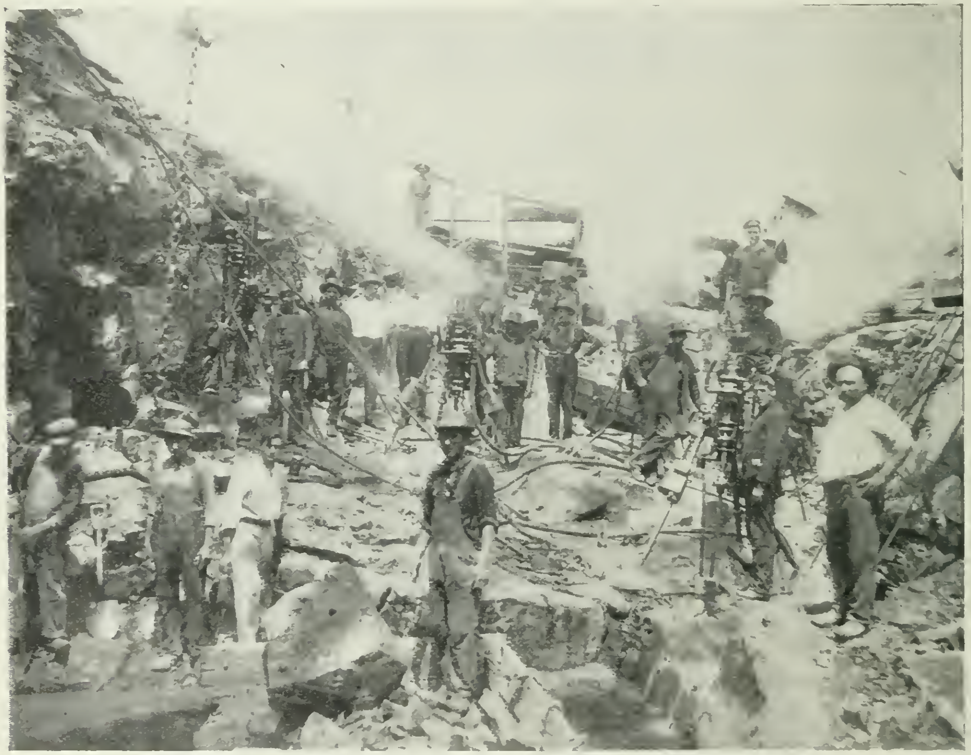

FIG. 4. DRILL IN ROCK CUT, WHITEHALL, N. Y.

A comparatively new, yet highly efficient addition to the contractor's equipment is the Leyner Drill Steel Sharpener. Among others is one in use by the Acme Engineering Co. at Herkimer, N. Y., and H. P. Burgard, Buffalo, N. Y., where it sharpens the steel used in conjunction with Sergeant, Butterfly, Jackhamer and other drills.

Owing to its great compactness, it is an ideal equipment for the contractor, as it takes up but little room, is fool-proof and simple in operation, one lever controlling the entire machine. Compressed air is the motive power. This sharpener uses an entirely enclosing die of conical shape in which the bit is made and gauged, insuring a perfectly formed gauged bit. The importance of properly sharpened steel in drilling operations has long been recognized as a factor in speedy and economical rock drilling, and the Leyner Sharpener offers a solution of the problem.

Submarine Drills are in use on a number of contracts along the Canal; by the Stewart-Kerbaugh-Shanley Co. at Three Rivers, New York; the Acme Engineering Co. at Herkimer; Huston Barnard at Little Falls; James Stewart Co. at Brewerton, N. Y., and Great Lakes Construction Co., North Tonawanda.

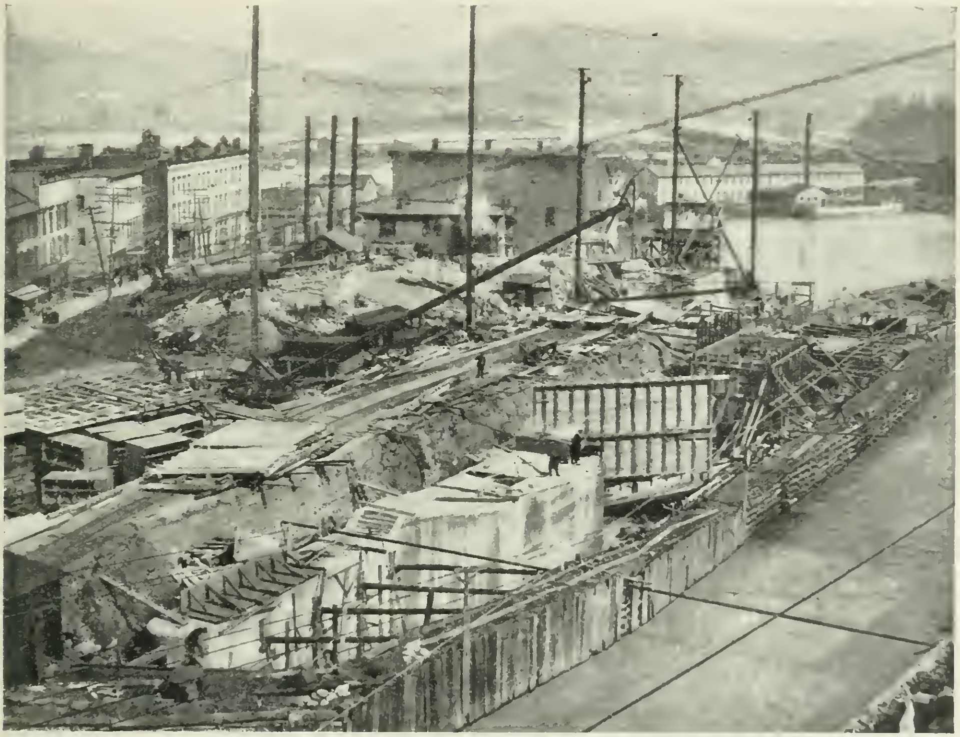

FIG. 5. WHITEHALL, N. Y., A. G. & P. CO.'S CONTRACT. AIR HOISTS.

They are of the H-64 type, with a cylinder 5½ inches in diameter and 8-inch stroke. This style of drill is considered standard by contractors having heavy submarine drilling to do, besides being used on the larger deep hole drill wagons. It is of the well-known New Ingersoll type, and is a machine of great simplicity and durability, the valve action is independent, being operated by air or steam and controlled by the piston, the drill is bolted to a slab back to run in guides and hoisted by means of a cable and donkey engine.

The deep-hole drill Fig. 3, is one that has been used with great success in meeting deep-hole drilling conditions on certain sections of the New York State Barge Canal by the Acme Engineering Co. at Herkimer; Huston Barnard at Little Falls; Shanley & Morrisey at Mechanicsville; Great Lakes Construction Co., Pendleton, N. Y.; Lane Bros. on the Genessee River. The holes put down were 4 inches in diameter and 15 feet deep. As high as 160 to 200 feet of hole per shift per machine was drilled. The machines were of the 15-foot feed, turntable type, mounting a drill of 5½-inch cylinder diameter and 8-inch stroke, H-64 Submarine type. The canal construction where this type of drilling rig was employed consisted in the deepening of a portion of the Hudson River Channel to form a waterway for barge traffic 200 feet wide and 12 feet deep in the clear.

The running gear is of the three-point suspension type, comprising heavy steel wheels with flanges for travelling on a 6-foot 3-inch gauge track and provided with power traction, through the medium of a chain drive from a reversible steam engine, mounted on the wagon. The engine is about 7-H. P. and, while not intended for continuous traction, supplies sufficient power for moving the wagon from hole to hole. A hand wheel and steering gear are also provided at the front end of the wagon.

The drilling engine and its guides, derrick for hoisting steel, etc., are carried on the turntable, which is mounted just past the center of the wagon, at the rear end. This turntable runs on balls. A system of sheaves and ropes suspends the drill from the top of the derrick, from where the ropes lead to a reversible hoising engine which is fastened to the back of the drill guides. Powerful hand brakes on the hoist regulate the feeding of the drill. Heavy jack screws are provided for supporting and steadying the drill frame during drilling operations. The swinging of the turntable is accomplished by means of a geared hand winch and rope. A half circle, 10 feet in diameter, is described when swinging, and the holes can be placed anywhere on this line.

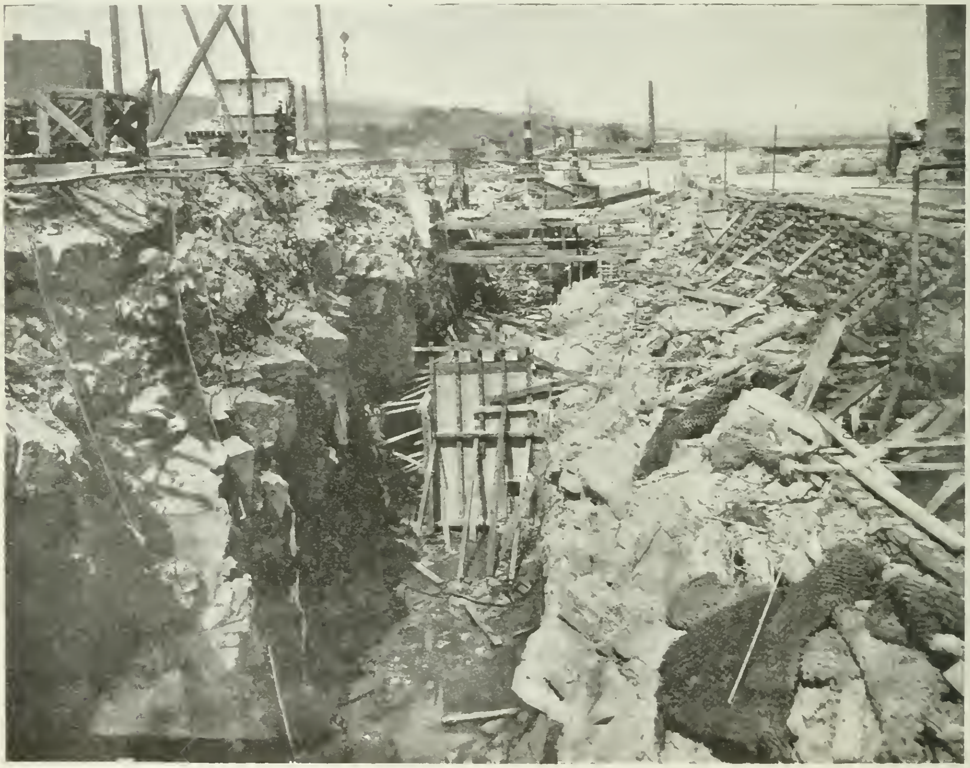

FIG. 6. ROCK CUT FOR LOCK, WHITEHALL, N. Y.

A brief description of the manner of handling and methods of drilling with the turntable rigs follows: The progression of drilling operates by the drill frame being swung at right angles to the line of progress, the jack screw set and a hole drilled; the drill is then raised and swung parallel with the line of progress and another hole drilled; the drill is then again swung at right angles to the opposite side and a third hole drilled. In this manner three holes are put down from each position of the machine, two on a line at right angles, the distance apart depending upon the sweep of the drill frame and one-half this distance in advance of or behind the others, and on a line midway between them. The drill wagon is then moved forward or back the proper distance and three more holes drilled. When the needed length has been covered, the drill is moved and another triple row of holes, paralleling the first, put down, and so on continuously. In the meantime, after sufficient ground has been drilled, blasting may be inaugurated, without interferring with the drilling.

For successful drilling of deep holes it is necessary to devise some means of ridding the holes of cuttings. The only successful method of accomplishing this is to use a water jet alongside of the drill steel. A pipe about ½ inch in diameter is suspended from the top of the derrick, which can be raised or lowered to suit the position of the drill bit. This will give the best results when handled so that the end of the pipe will not be more than 12 or 18 inches above the bottom of the hole. This pipe is connected by means of rubber hose with either a steam pump mounted on the top of the turntable, the pump suction being connected to any convenient water supply, or to a water pressure line. The amount of water is under the convenient control of the operator. In operation the drill runner stands on the turntable where he has control over the operation of the drill. The helper tends to the water jet and steel, lowering the pipe with the steel. As soon as a hole is finished a wooden plug is dropped in to keep it clear until ready for loading. The steel used was solid, 2 inches in diameter, 15 feet long, with a 4-inch cross-bit.

Outfits such as those mentioned above are being built by this company for a diversity of applications and are fast taking their place as necessary adjuncts to the contractors' equipment. They find their application in the economical excavation of rock in quarries, rail road cuts, canals and work of a similar nature where holes of a great depth are required. Their advantage for this class of work over the ordinary tripod drill are manifold, principally noticeable in the saving of time and labor. As stated they are designed to drill deep holes of large diameter, requiring fewer changes of steel and making heavy power loading possible, so that springing of holes becomes unnecessary. The speed and ease with which these machines are moved about makes possible the accomplishment of more drilling.

With tripod drills a great deal of time is consumed in moving from hole to hole, requiring considerable labor to do so. With these rigs several holes are drilled at one setting. The accurate spacing of holes of large diameter equally distributes the work, making it possible to break more ground with fewer holes.

PNEUMATIC TOOL EFFICIENCIES*

BY H. L. BRACKENBURY.

The pneumatic hammer is a combination of a cylinder, reciprocating piston, a valve controlling the flow of motive fluid to and from the cylinder and a throttle valve in the supply pipe. All the earlier engines were designed to produce rotary motion or to work pumps. The idea of using a free piston was first suggested as a good means of rock drilling. Among the earliest inventors in this field was George Low, an Englishman, who in 1865 patented a rock-drill having a hammering piston. Low is perhaps chiefly interesting as being the first to show a grasping-handle with manually-operated throttle valve within the control of the operator's fingers. Low was followed two years later by Doering, another Englishman, who was the first to patent a pressure-operated valve for this class of machine, in which the piston and valve are mutually inter-dependent, a principle used in all modern pneumatic hammers.

The first serious attempt to produce a practical metal-working pneumatic hammer seems to have been made by Boyer, of St. Louis, who, in 1883, patented a chipping machine with a grasping-handle and a throttle valve controlled by hand. Benjamin Brazelle, of St. Louis, in the early eighties obtained a patent in the United States for a steam pump disclosing a differential-area piston attached to a pump plunger, together with a differential-area valve, each of which served to control the operations of the other. Boyer seems to have drawn inspiration from Brazelle's invention, for in 1896 he brought out a metal-working pneumatic hammer involving Brazelle's design, but modified to suit the conditions of chipping, caulking, and riveting.

It was soon found that there was a large field for pneumatic hammers for closing rivets, and this demand for pneumatic riveters led to the invention of the hammer in which a comparatively short piston was made to travel a distance much in excess of its own length.

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*From a paper read before the Coventry Engineering Society, Coventry, England, January 23, 1914.

Boyer was probably the first to make a long-stroke hammer about 1899 by employing a valve at each end of the cylinder connected together by two rods of small diameter placed in longitudinal passages drilled in the walls of the cylinder. Meissner of St. Louis at about the same time brought out a long-stroke hammer with one valve only.

The problems presented to the manufacturer of pneumatic tools differ considerably from those involved in the production of other machines actuated by a fluid under pressure. The desirable qualities in a pneumatic tool in their order of importance appear to be: Reliability, power, cheapness, lightness, ease of handling, compactness and low air consumption.

ENORMOUS WASTES OF AIR.

Up to the present probably too little importance has been attached to the last of these. It is no uncommon thing to find a large and expensive air-compressor plant eating up power and delivering enormous volumes of air to supply the incessant drain of leaking pipes and hose, and the intermittent demands of most wasteful types of tools. Perhaps it would be no exaggeration to say that quite generally the amount of air lost by leaking hose is almost equal to that used by the pneumatic tools themselves. Suppose there are a number of leaks equivalent to a circular hole of about 1-10 in. in diameter. If the air supply be at 100 lb. per sq. in. pressure, the air leak will be about 15 cu. ft. of free air per min. or about 2 cu. ft. per min. of compressed air. The power required to compress this will be nearly 3 hp. In other words, the leak would waste about 120 cu. ft. of compressed air per hr.

METAL DRILLING MACHINES.

The factors governing the design of pneumatic drilling machines are entirely different from those for fixed machines. In the latter case, the machine is designed to run the drill at the speeds and feeds which will give the quickest penetration without undue wear to the drill. In the case of the pneumatic drill, the power is the governing factor, and therefore the design must be such as to use that power to rotate the drill at the speed at which the greatest penetration is given for the power. This is a slow speed, not a high one. The author found that an ordinary drilling machine requiring, for the same rate of penetration with fast speed and fine feed, double the power required with slow speed and coarse feed. These experiments were made with a drill in careful alignment with the work, and not with a pneumatic drilling machine supported by a springing arm and starting with the drill at anything but right angles to the surface of the work. The result is that the best effects are obtained by running the drill at slow speeds. The limits in this respect would be reached if the pressure required to feed the drill were more than could be conveniently given by the feed gear or the torque exceeded the strength of the drill body or cutting edge.

SPEEDS AND FEEDS.

When the air is allowed to flow into the drilling machine, a high speed of rotation is set up until the feed is applied by the feed screw. The more rapidly the feed screw is rotated the quicker will be the penetration of the drill and the slower will the drill rotate, with the final limitation that if the feed is too rapid, the drill will stall suddenly and there will be no penetration. This appears to be a curious paradox, for, apart from considerations of wire drawing, the indicated horsepower of the pneumatic engine would seem to be dependent on its speed and the pressure of the air. The result arrived at is that the maximum speed of penetration is given by that speed of rotation at which the machine develops its minimum horsepower, but its maximum stable torque.

Considerable experience of running drills under test conditions has proved the importance of applying the feed with judgment. A man used to this work can get much better results out of a drill than can another man, equally intelligent and skilful, who is not so accustomed. It requires the greatest judgment to feed the drill so rapidly that it shall just escape stalling.

The idea of a minimum speed at which the pneumatic drill will run without stalling is of importance, because it should help to fix the gear ratio to be employed between the pneumatic motor and the twist drill. This critical speed is probably dependent not only on the size of the twist drill and the material it is to cut but also upon the laws connecting the torque of the pneumatic motor with its speed of revolution, while this relation in its turn depends upon the pressure of air supply and the length and bore of the flexible hose.

The history of other prime movers would indicate the probability that there will, and should, be an increase in the speed of revolution of the pneumatic motors. Everything is to be gained by obtaining increased power from the same piston by running it faster, provided the design still ensures reliability and good wearing qualities. If this change occur, it will involve an increase in the gear ratio between the drill and pneumatic motor.

Pneumatic drilling machines may be divided into two classes. The first class comprises those operated by an engine of the piston and crankshaft type, the second those which rely upon some form of rotary engine. The second type is attractive on account of its beautiful simplicity, but, so far, the author has not found one capable of giving as large a torque for a given air consumption as those of the first type. The principal difficulty in producing even a reasonably efficient rotary pneumatic engine is the large leakage, which seems almost inevitable.

In considering the efficiency to be expected from either type, we should remember that the problems to be faced by the manufacturer of an engine as minute as that required for a pneumatic drill are peculiar to the production of any small device operated by a fluid under pressure. Since the periphery of a body is proportional to its linear dimensions, while its area varies as their square, it follows that the leakage which occurs at a periphery assumes greater and greater relative importance as the size of that part decreases, and leakage is the principal bugbear of the designer of pneumatic tools.

TESTING PNEUMATIC DRILLING MACHINES.

The measurement of the brake horsepower of a pneumatic drilling machine offers no particular difficulty if great accuracy be not required. For commercial purposes a prony brake is quite satisfactory. If, however, it be desired to investigate comparatively small changes of brake horsepower, a number of difficulties have to be surmounted.

Two forms of brake have been tried. The first consisted of a hollow copper jacket resting on a sheave, which was driven by the drill. The back center of the drill abutted on a support carried on an old lathe shifting head. The whole arrangement was fitted to a discarded lathe bed. Arrangements were made to keep a stream of cold water flowing continuously through the copper jacket. The latter was lined with lead, so as to bear evenly on the sheave. To one end of this copper jacket there was attached a heavy weight resting on a spring-balance, while a lighter weight attached to the other end was immersed in a vessel of oil, which damped down the oscillations until they did not exceed about ¼ lb. on the spring balance. Of course the lighter weight was corrected for the up-thrust of the oil. This arrangement was only fairly satisfactory. The brake used with it consists of a fine-quality cotton webbing, and the sheave has been made of larger diameter so as to minimize the rise of temperature.

It was found that over the speed range under investigation, 150 to 200 r.p.m., the horsepower developed increases more slowly than the revolutions. This speed range only was considered, because, it corresponded to the actual rate at which the drill would be run in practice.

TESTING PNEUMATIC HAMMERS.

The practical testing of pneumatic drills is difficult, but the testing of pneumatic hammers for power is even more so. The apparatus used in testing pneumatic hammers consists of a massive cast-iron bed provided with T-grooves, so that a heavy block may be bolted to it in any desired position. Against this block is placed the handle of the hammer to be tested. The snap of the hammer abuts against a heavy block, which can swing about a vertical pivot fixed to the bed. This swinging block is controlled by a spring, which can be adjusted by means of a screwed bolt passing through the fixed abutment. To the swinging block is fixed a light-steel arm carrying a stumpy pencil, the point of which rests on a strip of paper which can be reeled by hand off one drum on to another. As the instrument is only required to give the speed of the hammer, and a general idea of the type of oscillation produced, there is no need to employ a uniform drive for winding the paper.

Finally, although the production of a perfect pneumatic hammer appears to be more difficult than the production of a perfect pneumatic drilling machine, the author believes that the designs of hammers have reached a point nearer finality than the designs of drilling machines.

The 650 large ventilating fans in the anthracite mines of Pennsylvania are estimated to deliver 45,126,000 cubic feet of free air per minute.

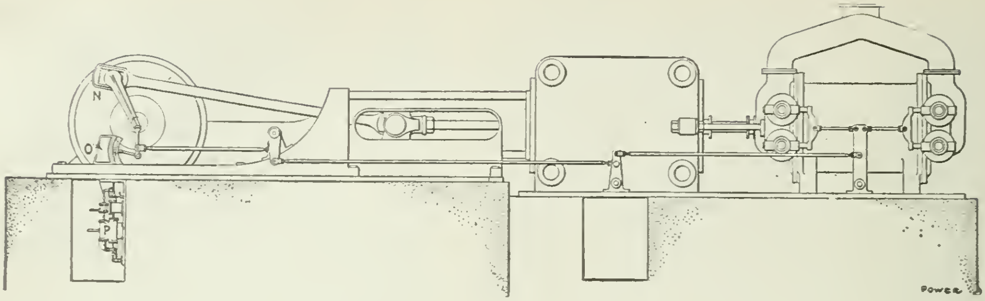

FIG. I. HOLMAN BLOWING ENGINE.

A NEW BLOWING ENGINE

Prior to the introduction of the gas engine, it was the general blowing-engine practice to limit the piston speed to 600 ft, per min., although cases were known where speeds of 800 ft. were employed. To furnish the requisite amount of air for the blast furnace at such speeds as this required a ponderous and costly engine, and it was found desirable to increase the piston speed to 800 or 1000 ft, per min. to keep down the size of the engine. As a consequence, it was necessary to adopt some new design of blowing tub with much larger valve openings than formerly, so that the cylinder at the increased speed would be properly filled with air. To meet these requirements a new type of blowing engine has been designed by R. C. Holman. Its construction is shown in the accompanying illustrations.

It is claimed by the designer that a blowing engine of the type shown can be built having inlet ports 25 per cent. of the area of the cylinder, and outlet ports 15 per cent. of the area of the cylinder, with a volumetric clearance of not over 1 per cent.

To remove both inlet and outlet valves from the cylinder it is necessary to take off the bonnet and withdraw the valve exactly as any Corliss valve is taken out. This valve contains all of the inaccessible parts of the air-distributing mechanism and will fit in any of the valve ports in the cylinder, provided that the ports are all bored alike. One complete valve in reserve then will provide a full set of repairs for any of the valves.

In the past, the use of flat girdiron and Corliss valves for blowing engines has not been attended with the best results, on account of the difficulty in properly lubricating the inlet valves. There is always enough oil pumped into the cylinder to properly lubricate the outlet valve, as the air leaving the cylinder is laden with oil. In the Holman machine the oil is pumped directly on the surface of the inlet valve at the edge of the port.

Fig. 2 shows the inlet valve-gear side of a horizontal blowing cylinder, and Fig. 3 the out-

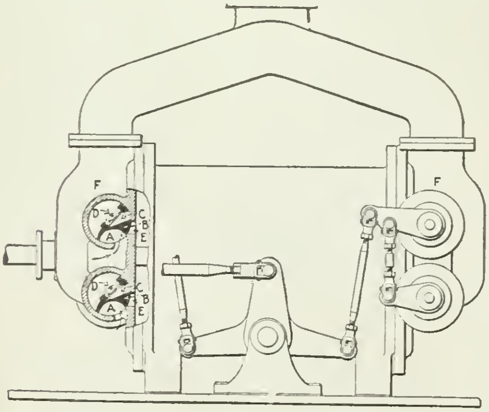

FIG. 2.

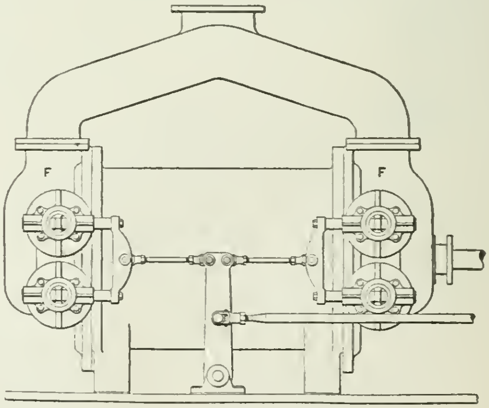

FIG. 3.

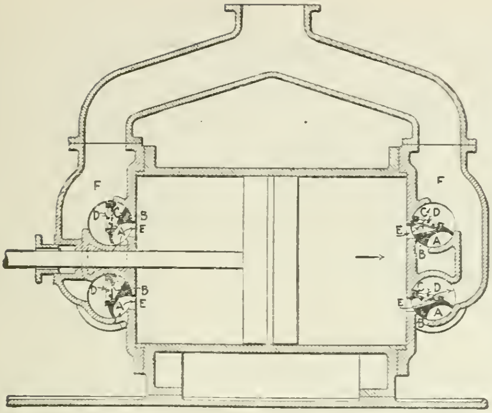

FIG. 4.

let valve-gear side. Fig. 4 is a section on the vertical center line through the cylinder and shows the valves in their proper relative position for the piston as shown. Fig. 5 is a section through the center of the valve and shows the outlet gridiron valve at the back of the inlet Corliss valve.

As will be apparent, the cuts show a steam-driven unit. The power is taken directly from the crankshaft and pin, while with a gas engine the valves are driven by eccentrics mounted on a layshaft, similar to the manner in which the inlet and outlet valves on the gas cylinder are driven.

Referring to Figs. 2, 4 and 5. *A* represents the inlet port through the inlet Corliss valve *B*, and *C* is the outlet port. The ports *E* in the cylinder head are alternately inlet and outlet ports, depending whether the piston is approaching or receding from the cylinder head. Each cylinder head contains two valves exactly alike, which are connected and work in unison. It is because both ports are used as inlet or outlet, as the requirements may be, that it is possible to secure such large openings with so small volumetric clearance.

The circular Corliss valve *B* of the sections shown in Figs. 2, 4 and 5 is given the proper oscillating motion by the valve-gear shown in Figs. 2 and 3, which is driven from the crankshaft in the case of a steam engine and from the layshaft of a gas engine. It is provided with the inlet and outlet passages referred to, and is fitted to a tee-headed valve stem *M* in the ordinary manner.

At one end of the outlet passage *C* through the valve *B* are cast a series of bars making gridiron openings through the valve, as in Fig. 5. The valve *B* is machined at this point to form a seat for the gridiron valve *D*, the openings through which correspond to the gridiron openings in the valve *B*, Rectangular ports *E* are cast in the cylinder head and act as inlet ports to the cylinder when the valves are in the position shown at the left of Fig 4, and as outlet ports from the cylinder when the valves are in the position shown at the right of Fig 4. At the center of the cylinder *F* is a passage connecting the discharge from each valve with the blast pipe. Fig 5 is a horizontal section through *F*, and Fig. 2 is a section at one side of *F*. In Fig. 5, *G* are thrustwashers with a spring to hold the valve *B* from slapping back and forth with the movements of the gridiron valve *D*. In practice, however, these washers are only needed in starting, as the unbalanced pressure of the valve stem *M* is more than the friction of the gridiron valve *D*. A cam bar *H* gives motion to the crosshead *I*, which in turn operates the gridiron valve *D*, the thrust-washers *K* being used to transmit motion and at the same time allow the gridiron valve to oscillate with the Corliss valve *B*. The crosshead *I* does not oscillate, but has a sliding motion in the bonnet *L* from the cam bar *H*. At high rotative speeds it has been found preferable to substitute a link-driven mechanism for the cam on account of the liability of noise if the cams are not carefully fitted.

The outlet drive mechanism is shown in Fig. 1, and consists of an arm keyed to the crankpin of the engine and set so that the pin at its end describes a circle. A quadrant *O* is fitted to the engine frame. In this quadrant slides a block to which is attached the link. The position of this block is governed by the piston in the relay oil cylinder *P*. The pressures in the blast pipe and blowing cylinder act upon a pilot valve which allows oil pressure to enter the actuating cylinder and so place the block in the quadrant that the outlet valve will open only when the pressure in the blowing cylinder is equal to that in the blast

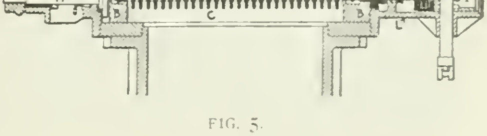

FIG. 5.

pipe. For example, if for some reason or other the blast pressure should suddenly drop, the pilot valve would immediately move, due to the. difference in pressure between that to which the air was being compressed and the blast pressure. This movement would allow oil pressure back of the actuating piston and change the piston of the block in quadrant *O* to such a point that the outlet valve *D* would open when the compressed air in the cylinder would equal in pressure that in the blast pipe.

The actions of all the valves are positive. The time of opening and closing the inlet passage to the cylinder is determined by the Corliss valve *B* and is fixed; the inlet is opened when passage *A* is in communication with port *E*. The time of closing the discharge is determined by the Corliss valve *B* and is fixed. The time of opening the discharge is controlled by the discharge valve *D* and depends upon the pressure of air in the cylinder with relation to that in the blast pipe. There is never any possibility of the inlet and outlet ports being opened at the same time and the gas coming back from the blast furnace —*Power.*

MONEY SAVED?

A gentleman [This is English, you know] had become convinced that a tin lode existed in the Saltash neighborhood, Cornwall, England, and considerable sums of money were spent in trying to locate the lode, but without result. At this period the gentleman came into contact with a miner—an experienced Cornish underground man of the best type. The miner said to the capitalist that he would show him a good lode on condition that the sum of 5 pounds were paid to him for his trouble. His offer was quite ingenuous, because he specified that, if the lode were not found he was content to receive nothing at all. The miner supplemented his offer by undertaking to open the lode, with the aid of three other men, and to work for two days—the capitalist paying labour charges only in the event of a lode being found. Here was a "sporting" offer. The miner's conditions were actually refused! The capitalist, in effect, said that the miner ought to disclose the lode for nothing! Naturally, the miner turned on his heel and went his way. Probably the capitalist is still digging and delving in the hope of finding the lode.

THE SECOND SIMPLON TUNNEL

One of the most important engineering undertakings at present being carried out in Switzerland is the completion of the second Simplon Tunnel, an interesting account of which, here given in abstract, is furnished by a Swiss correspondent of *The Engineer*, London.

Work was begun on the north side on December 20, 1912, and on the south side on March 30, 1913. About 2 miles 1300 yards have now been completely excavated, and 2 miles 780 yards completely lined with masonry; while it is hoped that in all 3 miles 618 yards will be excavated during the present year, and the same length lined, so that, should nothing happen to disturb these calculations, 51 per cent. of the total length will have been excavated by the end of 1914, and 49 per cent. lined with masonry. The second tunnel will be slightly more than 24 yards longer than the first, being 12 miles 588 yards in length.

The ordinary visitor to Brigue— or, for that matter, to Iselle—where are the north and the south portals respectively, sees little to indicate that a great enterprise is being carried out. Outside the actual portal of the tunnel, however, there are many signs of activity and of something going on within. At times a tiny compressed air engine, Fig. 1, may be noticed pulling long strings of small trucks, filled chiefly with artificial stone and bags of cement going in, and with excavated material coming out. Besides these small trucks there are, ready waiting, a number of ordinary broad-gauge trucks, all marked "Simplon Tunnel II." These, however, will be used only for quite the innermost part of the tunnel, when a considerable stretch of the portion near the portal has been completed.

There are also various buildings; that, for instance, from which the whole enterprise is being directed, the same building as that from which the first Simplon Tunnel was managed; but most striking of all in appearance, because of their red colour, are the air reservoirs containing air at as high a pressure as 190 atmospheres (say, 1¼ tons per square inch) for furnishing the power for the engines and for the rock drills. A pressure of from 180 to 190 atmospheres is required for charging the air reservoirs of the engines, but for the drills only from 6 to 8 atmospheres.

As is well known, the shaft of the second

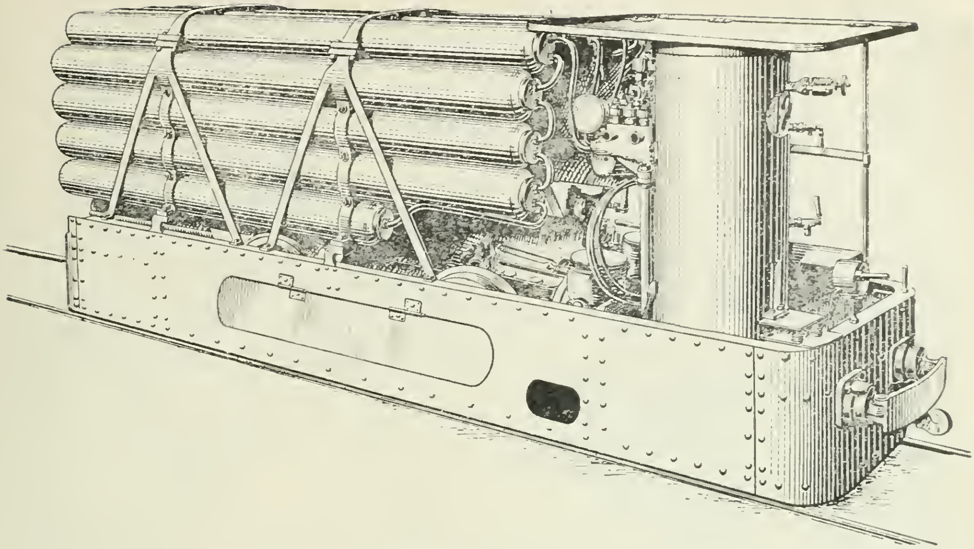

FIG. I. COMPRESSED AIR MINE LOCOMOTIVE.

Simplon Tunnel, a working gallery 3.20 m. wide and 2.5 m. high, was pierced parallel to the first tunnel as the work proceeded, and was connected to the latter by transverse galleries every 220 yards. It is generally admitted that, without this system of parallel shafts and transverse galleries for drawing off water and for ventilation, the first Simplon Tunnel would have taken consideraly longer to construct, and would have required correspondingly more capital. This second tunnel is being formed by enlarging this gallery.

A point of considerable interest in the construction of the second tunnel is the masonry lining, which does not consist of natural stones, as is the case with most Alpine tunnels, but of artificial stone composed of cement, limestone and sandstone, and made in the shape of ordinary bricks, although, being whitish-grey in colour, it does not look like bricks. This artificial stone is manufactured in works in Brigue, close to the north portal of the tunnel I may say here that there was strong opposition at first to its employment, principally because it was feared that it might not prove strong enough to withstand the pressure brought to bear on it. It should be stated, however, that this stone is used only in the dry portions of the tunnel, natural stone being used in the wet portions and in places where the pressure is very heavy, both for the root of the tunnel and for the abutments. What apparently turned the scale in favor of these artificial stone-bricks is the success with which composition stone and ordinary bricks have been used in tunnels in England. Moreover, the lining of the tunnel with these light artificial stones, uniform in shape and size, is far simpler than with natural stone, which must always be brought from some distance, and often from very far, in huge blocks. With artificial stone, moreover, a good deal of machinery can be dispensed with, notably the compressed air winches for lifting the stone up, which are notoriously troublesome to manipulate; and in the present case, when the first tunnel can naturally not be used for any purposes whatever, the saving of space is a great desideratum.

Since July excavation has been going on by means of rock drills—see Fig. 2—worked, as already stated, by compressed air. Everything, in short, is done by compressed air, and consequently the ventilation has proved satisfactory, despite the length of the tunnel. Save for the smoke from the blasting, there is, indeed, little to foul the atmosphere.

From May 23rd last, when the north heading was at kilom. 4 until the end of July, the work of boring had to be accomplished by hand. Towards the end of the month, however, a number of rock drills were introduced,

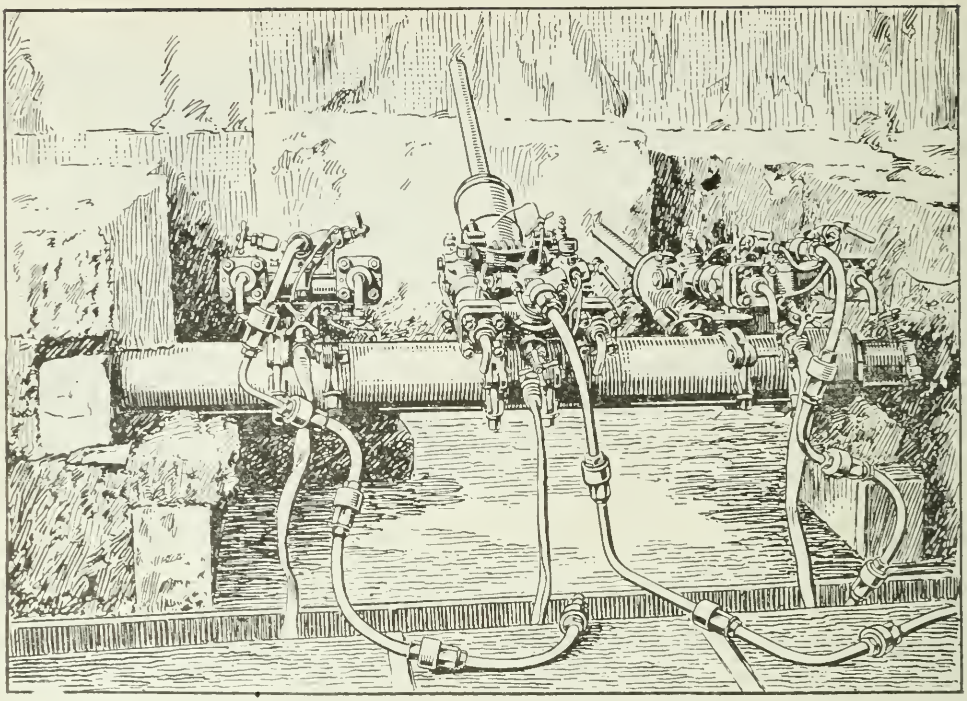

FIG. 2. ROCK DRILLS IN SECOND SIMPLON TUNNEL.

and work progressed much more rapidly. In this part of the tunnel it is essential to begin the lining without delay as soon as the excavation is complete, for the rock must not be left exposed to the influence of the atmosphere a single day longer than is absolutely necessary. In this part of the tunnel timbering is employed to withstand some of the immense

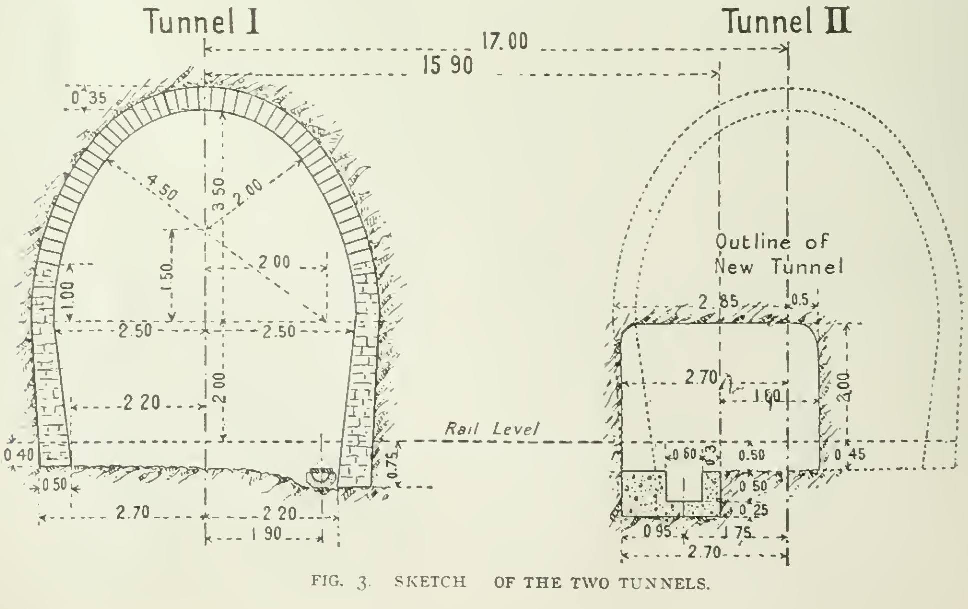

FIG. 3. SKETCH OF THE TWO TUNNELS.

pressure, while for safety's sake, in the first tunnel, in places which showed signs of having suffered slightly, iron centerings have been built in, the intervening spaces being filled in with strong iron plates.

No blasting takes place in the second gallery when a train is passing through the first, because of the transverse galleries and because the distance between tunnel and heading is only about 26 ft. It is sometimes urged that this distance is too small, and the calculations as to the sum at which the risk involved in completing the second gallery should be put were all based upon the fears entertained of injuring the first tunnel while blasting was going on in the second.

The latest figures available—those of November 30th, 1913—show that on the north side, on which work had then been going on almost a year, a mile and a-half were completed, and on the south side three-quarters of a mile, of 11.5 per cent. on the north side and 6.5 per cent. on the south side—altogether 18 per cent. of the total length of the tunnel.

The Simplon Tunnel, it should be recalled, is the lowest of the great Alpine tunnels, its greatest altitude being only 2313 ft. above the sea level, which is 1476 ft. lower than the highest point in the St. Gotthard Tunnel.

As will be seen from the accompanying sketch, Fig. 3, the present distance, axis to axis, between the first tunnel and the gallery or heading is only 15.90 m. (slightly over 52 ft.), but when the second tunnel is completed the distance from axis to axis will be 17 m., or 55 ft. 9 in.

In connection with the second Simplon Tunnel, it is interesting to recall the lengths of the five chief Alpine tunnels, together with the time which they occupied in construction. The tunnels are named in order of date of construction.

Tunnel	Yrs.	mths.	Length, Miles.
Mont Cenis	13	1	7½
St. Gotthard	7	4	9¾
Arlberg	3	0	6¼
Simplon	6	6	12¼
Lötschberg	4	0	9

SWALLOW ENGINEERING

North of Burlington, Vermont, lies a broad sand plain high above the head of Lake Champlain, through which the Central Vermont Railroad was to be carried with a tunnel. The sand, destitute of moisture, would not cohere, but crumbled away as soon as any excavation was made.

After several costly trials the engineers decided that the tunnel was impracticable. A young man in the engineers' office said he could tunnel the sand bank at small cost. He said that he could build the tunnel for so many dollars a running foot, but that he couldn't expect the railway people to act upon his opinion when so many American and European engineers had given it up. The managers, however, gave him a contract to build fifty feet of the tunnel.

On the face of the sand bank he marked the line of an arch larger than the proposed tunnel, and on this line drove sharpened timbers into the bank. Then he removed six feet of the sand and drove in another arch of twelve feet timbers, removing six feet more of sand. This process he repeated until he had space enough to begin the masonry. As fast as the masonry was completed the space about it was filled, leaving the timbers in place. He pierced the bank with the cheapest tunnel ever built, and it now stands as firm as on the day it was finished.

He was asked whether there was any suggestion of the method adopted by him to be found in the books on engineering. "No," he said, "it came to me in this way: I was driving by the place where the attempts were made, and saw that a colony of swallows had made their homes in the bank. It occurred to me that these little engineers had disproved the assertion that the sand had no cohesion. As at every swallow's home there is a self-sustaining tunnel without masonry, I thought that by extending their method I could build a larger tunnel. The bank swallow is the inventer; I am simply his imitator."

HIGH PRESSURE CAISSON WORK

In the construction of the piers for the Boulak Bridge over the Nile at Cairo, completed in 1912, the air pressures worked in by the "sand hogs" were near the record for such operations. For one pier the bottom of the caisson was 111½ ft. below the water surface, while for five piers the depth was 108 ft., and the air pressure carried reached as high as 50 lb. The working shifts for the different pressures ranged as follows:

Up to 28 lb., two gangs working 8-hr. shifts alternately.

28 to 40 lb., three gangs working 8-hr. shifts.

40 to 45½ lb., three gangs, each 6-hr. on and 12-hr. off.

45½ to 50 lb., six gangs working 4-hr. shifts.

50 lb. (during concreting of working chamber), four gangs working 3-hr. shifts, day only.

The time the men were required to stay in the air-lock for "decompression" on leaving the lock, varied as follows: Up to 35-lb. pressure, 1 min. for each 1.4 lb. of pressure; 35½ lb. to 42½ lb., 35 min.; 42½ to 45½ lb., 40 min., 45½ lb. to 50 lb., 45 min. Considering the long shifts and high pressures, cases of illness resulting from these conditions were not very numerous. Out of 493 men employed 100 were reported ill, the number of cases being 115. Of these, four proved fatal. The men were natives, and no difficulty was experienced in getting them to work in compressed air at ordinary rates of pay.

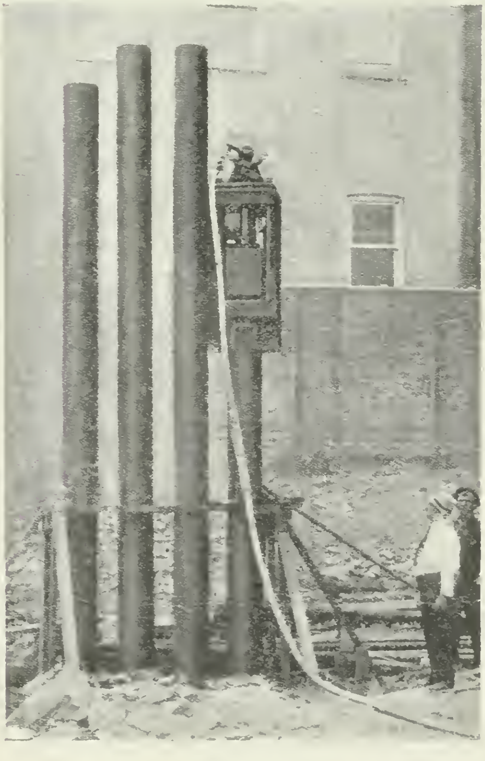

FIG. 1.

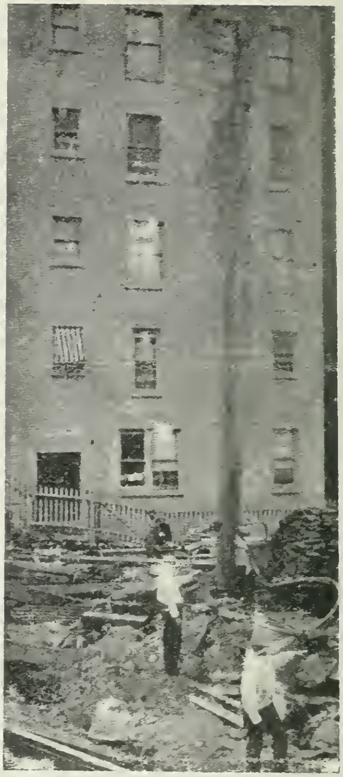

FIG. 2.

STEEL COLUMN CONCRETE FOUNDATIONS

In the preceding volume of Compressed Air Magazine, at page 6736 we describe a method of constructing foundations for high-class buildings which is now being extensively employed, especially in upper Manhattan, New York City, by the Underpinning and Foundation Company. It consists essentially in avoiding deep and costly excavations by instead driving vertical steel tubes 12 in. or more in diameter, down through sand, gravel, etc., until the solid rock surface is reached and filling the tubes with concrete reinforced by steel rods, compressed air being an essential agent in the operations. We here reproduce from the Scientific American a number of illustrations which show the details of the work very clearly.

In Fig. 1, we see several tubes in position for driving, with a special, self-contained air operated hammer in the act of driving one of the tubes. If the ground is very deep or hard the

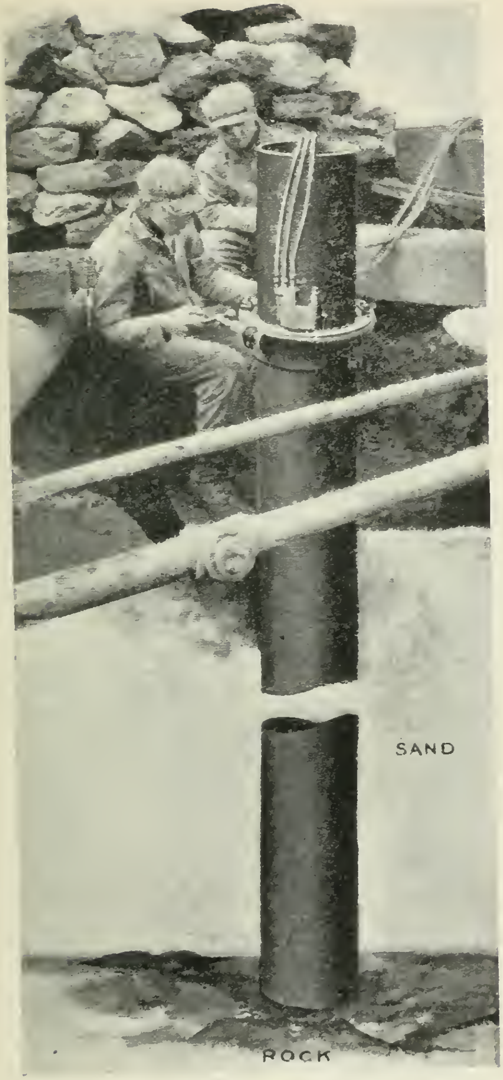

FIG. 3.

tube is not driven entirely home by the first, or even by the second driving. When the tube ceases to advance freely under the blows of the hammer, the driving is stopped, the hammer is lifted and swung aside by a derrick and a Navy air hose is then passed down the tube as far as it will go, and high pressure air is turned on in full volume and as suddenly as possible, which drives up a great quantity of sand and stones. Fig. 2 shows one of these blow-outs.

After this the driving is resumed, followed

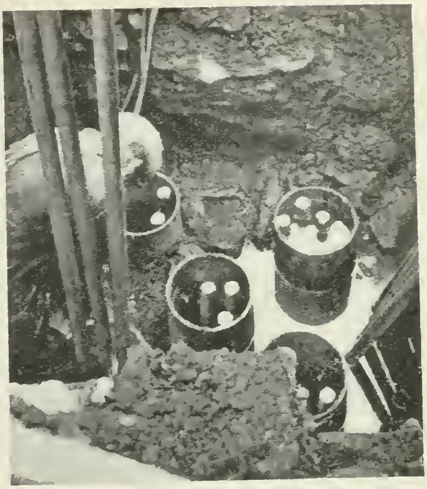

FIG. 4.

by another blowout. When the tube is down to the rock the air blows the surface clean and an electric light is lowered to show that it is all right, also steel sounding rods are used to test the soundness of the rock. This being found satisfactory, three or four 2-in. round steel rods are stood up in the tube and then it is filled with concrete even with the top.

The limit for single lengths of tubing is 20 or 22 feet, and when, as often happens, a greater length is required there are butted sections connected by watertight couplings. In any

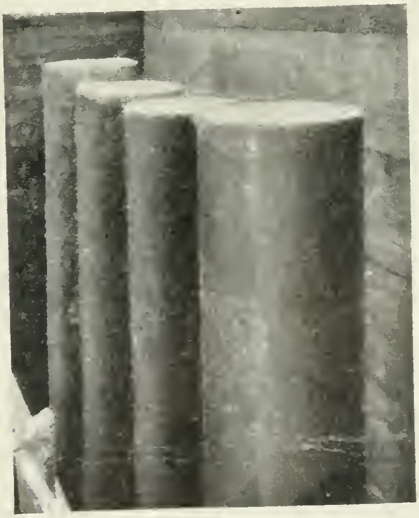

FIG. 5.

case the precise length for any tube cannot be determined beforehand, so that after a tube is driven down to the rock the top is cut off to the required length by the oxy-acetylene torch as shown in Fig. 3. In Fig. 4 we look down upon the tops of three or four of the tubes partially filled with concrete, showing the reinforcing rods in position and in Fig. 5, are shown the tops of contiguous piles completed and ready for their permanent load. How this is applied is sufficiently suggested in the sketch, Fig. 6.

The carrying capacity of these piles is enormous, a single 12-in. pile sustaining safely a load of 100 tons. Piers composed of groups of 16 of these piles have been used and the loading of such piers up to 1300 tons is not unusual. As the entire pile is tightly enclosed the possibility of deterioration by corrosion is found to be practically negligible.

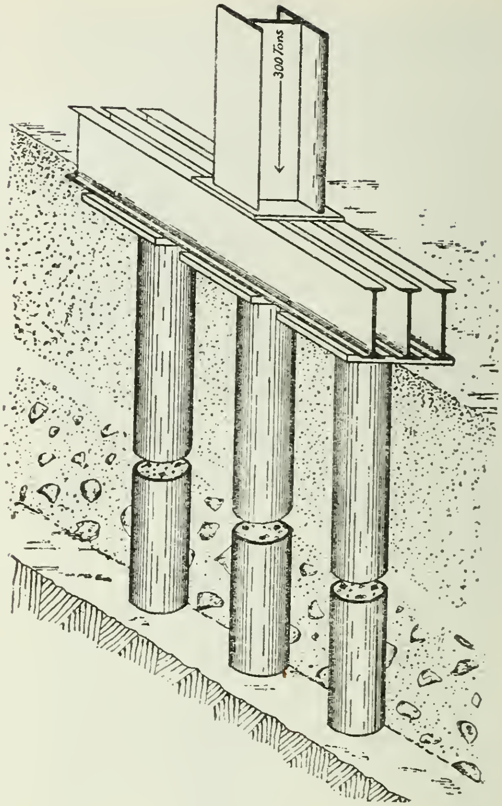

FIG. 6.

PENNSYLVANIA RAILROAD AIR BRAKE TESTS

An unusually interesting paper, discussing the modern air brake problem and giving account of elaborate tests made by the Pennsylvania Railroad, jointly with the Westinghouse Air Brake Company, was presented at the February meeting of the American Society of Mechanical Engineers, by Mr. S. W. Dudley, of Pittsburgh.

A train of 12 steel cars at 60 miles per hour stores up 224,000,000 foot pounds of energy. This is sufficient to raise the entire train 120 feet. With prevailing brake equipment such a train would be stopped by an emergency application in a distance of 1600 to 2200 feet, according to the truck rigging and brake shoe design. These tests showed that this distance has actually been reduced to 1000 ft. or to within the length of the train. This was the result of improvements in the truck brake design, involving the clasp brake, having two shoes per wheel, and the loctaion of the brake shoes with reference to the horizontal center line of the wheels, in addition to improved methods of applying the air brakes quickly and simultaneously and at a high pressure.

These tests emphasized, as has never been done before, the possibilities of improvement in efficiency and economy in regular service operation by proper attention to design and installation in order to permit the realization of the flexibility of improved air brake apparatus. These improvements center in the electric control of the brakes, giving quick, simultaneous and responsive action. The electric control has opened the way for maximum effect in practice of improvements in practically all the factors involved in air brake apparatus, all of which were covered in the development represented by these tests. The tests constituted a progressive development of brake rigging and brake shoes in connection with the scientific study of the air brake as a whole.

Trains of fifteen years ago were stopped in about half the distances prevailing in the practice of to-day. Increased size and weight of equipment brought an entirely new brake problem. These tests have solved it very completely.

The cost of making a ton of ice is: Coal, 40 cents; labor, 50 cents; ammonia, 10 cents; water, 5 cents; wasted power, oil, etc., 10 cents; total, $1.15.

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WESTINGHOUSE

The measure of greatness in men is achievement, and when we are able to gauge one's achievement not alone by its magnitude but by the good that has been done to mankind or to the world in general, that man is truly great. Westinghouse has left a lasting impression upon the industrial world by useful inventions, through the establishment of great business enterprses and in the strength of his noble personality. In lays of ancient Rome we read of men who were called great because they led armies to victory. Through such men the Empire was extended. Greece produced men great in art and letters and to such men as these monuments have been erected as examples to mankind. But it was not until Sir Isaac Newton unfolded the mysteries of Nature that the engineer and the man of science were looked upon as great. Sir Isaac Newton in the evening of his life said: "If I have done the public any service it is due to nothing but industry and patient thought," and it may well be said of Westinghouse that industry and patient thought have entered into every part of his life.

We see the great spectacle of human achievement in a man who labors day and night and produces something which adds to the happiness, prosperity and wealth of the world. Stevenson was the pioneer in transportation, and transportation is the means by which the world has been civilized and enlightened. Westinghouse followed Stevenson and made that transportation efficient and safe. He took our common neighbor, the air, and directed it to useful service. He led in the long distance transmission of electric power and he built great industries.

Westinghouse was great in his private life, great in character, in sympathy, in human interest and in that gentle personality and modesty which are so rare among inventors and men of activity and force. He was

"Of manners gentle, of affections mild,
In wit a man, simplicity a child."

COMPLETE CYCLE OF ROCK DRILL DRIVES

In our March issue, page 7155, there appeared a brief description of the new gasoline driven air pulsator percussion rock drill. While the drill is interesting in itself, having demonstrated its high power economy and complete practical success in operation, the real significance and importance of its appearance at this time may not at once be fully realized. It is to be noted that the drill successfully completes the cycle of possible applications of power to the driving of the reciprocating percussion rock drill.

In the beginning, as we all known, the modern rock drill was developed for mining and tunneling purposes, and compressed air for driving it thus found its first important and constant employment. Drills of the same general type, when their work was not underground, were quite generally driven by steam direct, and practically no other drive but air or steam was known for rock drills until well within the present century.

When electricity was beginning to get into full swing as an agent for the transmission of power to every mechanical device, the rock drill field could not be overlooked or ignored, and so experts in great number have struggled long to produce a satisfactory electric driven rock drill, but no device of that class has yet passed the stage of unsuccessful experiment, but all at once the electric-air drill appeared, and this not only solved the problem of the electric drive completely, but without sacrificing any economic advantage of the older types of drills, has developed additional desirable features of its own.

With the gasoline drive doing the wonders that it has done for the automobile, and especially in its having put the breath of life into the aeroplane, it was quite natural to think of its possibilities in connection with the rock drill. The history of the attempted adaptation for this latter service is quite similar to the electric record. There has been no lack of experimenting but a plentiful lack of success. The internal combustion principle is apparently no better adapted to the direct driving of a rock drill than is the electric current; at least it has no better success to show, but here too in the gasoline air drill the complete solution has come all at once and beyond further question.

The reciprocating rock drill can now be driven by either air or steam direct, by electric current or by gasoline, with the highest known efficiency whichever drive is adopted. This variety of drive enables the drill to be used in all localities accessible to man and under all possible conditions of working. In no case is any experimenting required as to what the drill will do or what will be the approximate cost for the doing of it.

It is a singular and notable fact that while there are now several builders of rock drills driven by air or by steam, one firm in all the world has the unique distinction of manufacturing drills operated successfully by either of the available drives here spoken of.

THE BREAKING OF DRILL STEELS

At a recent meeting of the Mining and Metallurgical Society of America an interesting discussion occurred (Bull. No. 68.) concerning the inability of drill steel to stand up in hammer drills.

Mr. LeFevre said that at Mineville in the use of hammer drills the difficulty had been to find the right material. Cruciform 1 in. stock did not seem to have enough metal, so that the company expected to try 1¼-in. octagon. The jackhamers using round hollow steel, break the shanks when the hole gets down 6 or 7 ft., and the borings do not come out freely.

Mr. Spilsbury stated that the peculiar fractures to which the hollow steel drill, under the impact of the hammer, seemed to be subjected, did not appear to be due simply to the actual blow of the hammer, but to an interior condition of abnormal strain in the structure of the steel itself. He thought that possibly the trouble was due to the method under which these hollow drills are produced. The ingot is first punched and then forged down on a mandrel. Any defect or ragged edge, on the punch originally used would cause striations along the interior surface of the hole and in the subsequent hammering down over the mandrel, these lines would never be entirely obliterated. The grooves might be closed but would probably include a slight film of oxide in their folds which would still remain in the finished drill, and under the jar of operation would naturally become a source of weakness This trouble would also be increased by the unequal annealing of the material during the time of its reduction, owing to the fact that surfaces exposed to the mandrels would be cooled more rapidly than the rest of the material and shrinkage strains would probably be set up. He believed that this was the direction in which to look for the cause of the rapid failures rather than to the quality of the steel.

R. M. Catlin said he had an idea that the breaking of the drills was due to inequalities in the steel, although he had never seen a longitudinal fracture in a drill. The fractures with which he was familiar indicated a nucleus, and correlation indicated that the fracture had begun from this nucleus and spread outward. As is observed in a flaw in glass, these were concentric rings spreading out from a central point. It seemed as though there were in the nucleus some substance which had developed, under the strain of the vibrations or of heat, a tendency to expand more than the elasticity of the steel could accommodate. This nucleus seemed to run through the length of the steel, and if broken anywhere, one could expect to find it. There can be had steel of all kinds and prices from 5c. to over 30c. per lb. As a matter of fact, the higher-priced steel does not seem to be the more durable. A trial of hollow steel having an absolutely round hole, gave no better results, even though it was a drilled hole.

W. L. Saunders said his company had experimented a great deal on the subject of the round hole. The steel problem is being solved, he said, not by American, but by foreign metallurgists, and the steel with a hole in it that is now standing up best under the hammer blow is of foreign make. Referring again to the difference between a piston and a hammer drill, in the latter the bit is pressed against the bottom of the hole, and is then struck a thousand blows per minute. Probably 10 per cent. of the blows are struck when the bit does not touch the bottom of the hole, since one cannot press a piece of steel against the bottom of a hole and hammer it without the steel's bouncing back.

Cars of improved design for the New York Subway will cost $10,000 apiece. These cars are 67 ft. long and 10 ft. wide, compared with 51½ ft. and 8¾ ft. respectively for the existing subway equipment. The car bodies will cost $6119 each; the motor equipment, $1100; control apparatus, $975; brake set, $911; each truck, $450; total for each car, $10.005.

COMPRESSED AIR IN CYANIDATION*

Compressed air has long been used in various branches of metallurgy for the ordinary mechanical purposes common to every industry, but in the cyanide process of recovering gold and silver from their ores there are several applications peculiar to that system which do not apply to industry in general and which may be of interest. Especially is this true regarding that modern development of the process known as "all sliming," in which ore containing precious metal is ground to such a point that nearly all of it will pass a fine wire screen having 200 openings per lineal inch, and is then stirred or agitated with the cyanide solution.

In the early days of cyanide metallurgy, the approved method of treating an ore was to grind it rather coarsely, place it in a tank containing a filter bottom, and leach it with the cyanide solution. By this method the surface of the charge in the tank—that portion exposed to the action of the atmosphere—gave a good extraction of its contained metal, while the interior of it—that portion with which the air could not come into contact—was found to give up its metal content at a much slower rate and in less degree.

Believing that oxygen was what was needed, some operators introduced compressed air under the filter bottom and forced it up through the charge, aerating the material thoroughly. This was one of the first uses, if not the actual pioneer application, of compressed air in practical cyanidation. The idea was even covered by patent, the scheme being to fill the bottom of the tank, under the filter, with a net work of stationary pipes perferated with small holes into which air could be forced to find its way through the sand in the tank. This operation was sometimes varied by connecting the bottom of the tank with the intake of a compressor, drawing the air down through the charge. This latter procedure was found to induce packing of the charge and was not considered as satisfactory as forcing the air upward, which loosened the sand and made it more permeable.

Finding that fine material interfered with rapid and even leaching of the tank contents.

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*From an article by Herbert A. Megraw in Engineering Magazine, January, 1914.

the two were separated and the clean sand leached by itself, a much more satisfactory method. The finer material, at first discarded, was later found to contain a good proportion of the valuable metal, often the most of it, and the problem of its treatment arose. It could not be leached, as it was too fine and packed so tightly in the tank as to be practically impermeable, and the only way in which it could be satisfactorily extracted was to keep it in suspension in cyanide solution while the dissolving progressed, and to separate the two after the extraction of the valuable metal was complete. The fine material, by common consent, has been called slime; and while the exact definition of the word has been the subject of much controversy, it is generally taken to mean the extremely fine clayey or colloid portion of the ore which may not be successfully leached. Its treatment bothered operators for many years, and in the devising of an applicable method, the agitation system, now highly perfected, was born.

At the mill of the El Oro Mining & Railway Co., at El Oro, Mexico, one of the early plants in America to attempt the separate treatment of slime, the material was agitated in shallow, rectangular tanks by means of compressed air introduced through a hose moved from point to point by an operator. The system made use of the mechanical efficiency of the air in keeping the solids in suspension, and also the oxygen in the air to supply that necessary in the completion of the chemical reaction. This method was troublesome and expensive, requiring too much labor to be economical, and was soon replaced by round tanks in which the agitation was mechanically done, using a central vertical shaft provided at the bottom with arms for keeping the solids in suspension, and air was added either through fixed pipes in the tank or into the suction of a centrifugal pump used to assist agitation. A later development made use of a hollow vertical shaft through which air was introduced, passing thence through hollow agitating arms and escaping through a series of small holes, thus combining mechanical and air agitation at the same time. These methods gave good results; but the notion of "killing two birds with one stone" had not been forgotten, and agitation by means of compressed air alone was studied until the tank known as the "Brown" or "Pachuca" was developed and became almost universally used.

The "Brown" tank is a tall cylinder of steel plate having a cone-shaped bottom and is fitted with a tube vertically placed in the center. This tube acts as an air lift, raising the mixture of solid and solution and discharging it near the top of the tank, thus maintaining a constant circulation and giving no opportunity for the solids to settle. The tank is very tall in comparison to its diameter, made so in order to minimize the chance of settling; and to further this object, the cone bottom is made so steep that solids can hardly remain on it. The usual dimensions of a standard tank of this kind are about 15 feet in diameter and 45 feet deep, although in some cases the proportions are varied. The central tube reaches from near the bottom of the tank, where compressed air is admitted, to within a few inches of the top. This latter point is the subject of many variations, some operators maintaining that the necessary conditions are complied with when the tube reaches only half way up the tank. It will be seen that this is an air lift working under practically ideal conditions as to submergence, and power requirements are not large. In a standard tank, which will hold about 100 tons of dry slime at the usual dilution, the operation is stated to require about 100 cubic feet of free air per minute, compressed to 25 to 50 pounds per square inch. The higher pressures are required to start operations after the tank has been without agitation for some time, and the lower ones to maintain agitation after it has been started.

Many other systems have been invented and put into use, most of which use compressed air as motive. One known as the Trent system operates by the use of a centrifugal pump in a tank of large area, having a flat bottom, and comparatively low. Such tanks may be 20 to 30 feet in diameter and 10 to 15 feet deep. The pump is fed from a point near the surface of the tank and forces the pulp through an appropriate gland in the tank bottom into a system of arms, made of pipe, placed so that they may revolve near the bottom of the tank. The arms are fitted into a grit-proof bearing, and the pulp exits are all curved in one direction, the force of the discharging pulp causing them to revolve in the tank after the fashion of an automatic lawn sprinkler. To supply oxygen to this system, air is introduced into the pump column from a compressor; or this may be done by arranging a sniffle valve in the suction, although this is likely to reduce the efficiency of the pump.

Probably the latest claimant for honor as an agitator is that known as the Dorr, which uses a flat-bottomed tank like that in the Trent system. The mechanism is like that used with the well-known Dorr thickener—a central shaft carrying two arms, inclined upward at an angle from the centre. Upon the bottom of these arms are a series of inclined blades, which act as rakes, drawing the settled material toward the centre of the tank. Upon reaching the centre, the slime comes under the influence of an air lift, which circulates it much as it is done in the Pachuca tank. The discharge of this air lift may be free, as in the Pachuca tank, or through a distributing canal fastened to the central shaft; in the latter case the discharged slime is distributed over the entire surface of the tank. Here again the air is made to serve two purposes. The particular advantage claimed for this tank is that it requires very little power, the mechanically moved arms revolving very slowly and requiring only from ¼ to ½ a horse power, while the air lift has no great height and small quantities of air under low pressures may be used. Tanks with flat bottoms and great area, compared with their height, are preferred on account of their low installation cost and also the influence upon the first cost of the milling plant. When tall tanks are used, costly excavations are required in addition to the heavy installation expense of the tanks themselves.

In addition to the uses named, compressed air performs many other duties about the cyanide plant, most of which, however, are purely mechanical. The air lift is used for elevating both pulp and solution, and compressed air is often used in connection with filtration, the separating of the solids from their treatment solutions. The precipitate resulting when gold and silver are thrown out of the solution is pumped through a filter press, either by means of direct-action pumps or by a monteju, and the cake formed is often partially dried by passing compressed air, sometimes heated, through it. Compressed air is largely used in the operation of fuel-oil burners to melt the precipitate into bullion, and in many other ways this transformation of energy may be considered almost indispensable about the modern cyanide plant. While all of these uses are important, naturally the one in which both chemical and mechanical properties are utilized is most prominent.

MINE ACCIDENTS

The report of the Bureau of Mines on metal mine accidents in the United States in 1912, shows 661 men killed, 4,502 seriously injured and 26,232 men slightly injured out of a total number of 169,199 men employed. The figures show a decrease of thirty-four deaths from 1911, despite the fact that Alaska, with twenty-one fatalities is included for the first time in the 1912 report. The death rate for 1912 was 3.91 for every 1,000 men employed as against 4.19 in the year 1911. The report on metal-mine accidents completes the mortality statistics for the mining industry for the year 1912 and shows in coal mining, metal mining and quarrying, a total of 3,234 deaths for the year, with a death rate of 3.22 as against 3.602 deaths in 1911 and a rate of 3.58 in every 1,000 employed.

This report has been published as Technical Paper No. 69, copies may be obtained by addressing the Director, Bureau of Mines, Washington, D. C.

MINING NOT THE MOST DANGEROUS

Recently the casualty statistics for persons employed in coal mines, on railroads and in steel mills of the United States, in the year 1911, were assembled for comparison. It was seen by the comparison that, for each thousand men employed, fewer coal miners were injured than railroad men or steel workers. Bulletin 69, of the United States Bureau of Mines shows that in 1911, the number of coal miners in this country was 729,279. Of this number 31,334 were injured more or less seriously. In the same year, according to the "Twenty-fifth Annual Report of the Interstate Commerce Commission," the railroads employed 1,669,809, and of this number 126,039 were injured. United States Senate Document 110, Sixty-Second Congress, bears testimony to the fact that 35,764 steel workers were injured of 158,604 employed.

A study of the figures contained in these government documents shows that there were about half as many coal miners as railroad men employed, and that less than one-fourth as many were injured. It is also shown that, while the mines employed 570,675 more men than the steel mills, the steel mills injured 4430 more than the mines did. A reduction of the figures to a common basis brings out the fact that, for each 1000 men employed, 42.96 were hurt in the coal mines, 75.48 on the railroads, and 225.4 8 in the steel mills.

AN APPRECIATION OF RATS

There is at least one region in the United States where rats are held in high regard. This is the copper mining district of Michigan. The regard entertained for the rodent does not, however, apply to the rats which dwell in and about the habitations of man. It is extended only to rats which never see the light of day, rats which make their homes hundreds and thousands of feet below the surfact of the ground—rats which frequent the copper mines. Rodents above ground are carriers of disease as well as costly preyers on the food and the buildings of man. Rodents underground are valuable to sanitation, preventives of disease; they indulge in no depredations for the reason they exist within rockbound walls enclosing no things possible for animals such as they to destroy.

Rats are the scavengers of the mines. They keep the workings clear of refuse. They are protected by the men, are often fed from dinner pails and have become so accustomed to the miners that they frisk about the workers wholly unafraid, secure in the apparent realization that, while elsewhere they are hunted and slain as enemies of mankind, underground they are treated as allies and are immune from harm. With their very existence concerned, no living creatures suffered more from the strike of the Western Federation of Miners in the copper country than did the mine rodents Not only was the food supply cut off in most instances, resulting in a heavy mortality from famine, but large numbers of rats were drowned when the pumps draining some of the shafts were put out of commission and workings filled with water. It is believed the survivors owe their continued existence to cannibalism. The strike is in progress only in theory now and mining operations are fast approaching the normal; but while the rats are far fewer in numbers, no carcasses are to be seen. The conclusion is obvious.

The rodent population of the mines apparently comprises various branches of the rat family as well as a conglomeration of several. There are white, brown and black rats, and rats with combinations of colors; there are rats of various sizes and of somewhat varied shapes; some with long tails and some with short. At some shafts food was especially provided during the period the workings were deserted of men; but in general the rodents were left to work out their own salvation. It will be a long time before the rats regain their normal numbers. These numbers are never such that the mines are overrun. Notwithstanding no warfare is waged by man, the rat population does not grow to proportions where it becomes a menace or a nuisance. Nature apparently regulates, and cannibalism no doubt plays a part. Rats have frequented the mines for many years, and yet in no case have they become in any way undesirable.—*Min. and Eng. World.*

NITROGEN DOUBLES LAMP EFFICENCY

A new type of lamp is announced with twice the efficiency of the tungsten lamps now in common use. The new lamp has a filament of tungsten, but the bulb, instead of being exhausted of air, is filled with nitrogen vapor at atmospheric pressure. The peculiar property of the nitrogen is that the tungsten filament may be operated at a considerably higher temperature than when in a vacuum, without the troublesome blackening of the bulb. The experiments thus far have been conducted largely with lamps of high candlepower; one of these lamps was over 6000 candle-power with a current consumption of 0.5 watt per candle, as compared with 1 and 1.25 watts per candle in the ordinary tungsten lamp. Small and medium-sized nitrogen-filled lamps have not yet been successfully operated at this high efficiency, but it is claimed that all tungsten lamps will give better service if filled with nitrogen than if a vacuum is used.

NOTES

The trustees of the village of Southampton, N. Y., have granted a gas franchise to Henry F. Cook of Sag Harbor, N. Y., with numerous restrictions and safeguards, among which it is provided that no gas holder shall be erected in or within two miles of the village, which puts Southampton ten years, more or less, ahead of New York City.

The heaviest railway construction ever undertaken in British Columbia is the 38-mile section of the Kettle Valley Railway from the Hope Range summit to Hope. This line, which includes 12 tunnels, is estimated to cost $3,000,000.

The largest double-acting pile driver ever built was used for driving concrete piles for the Intercolonial Railway's new pier and shed at Halifax, Nova Scotia. The combined weight of the hammer with follower and follower guide is 24,000 pounds; weight of the ram only, 4000 pounds. The diameter of the cylinder is 14 inches and stroke 36 inches. The hammer drove 1800 reinforced concrete piles 24 by 24 inches square and 37 to 77 feet long.

The extension of the distribution of gas under high pressure for heating and lighting has brought lead wool into prominence among gas engineers abroad. On a long length of 4-inch and 6-inch steel mains jointed with this material in England, a test of 60 pounds of compressed air was applied for a period of six days and nights, but it is stated that no leakage whatever was recorded. In connection with the new water works for Logos, in Southern Nigeria, some 22 miles of 28-inch pipes will be jointed with lead wool, and the caulking is being carried out with pneumatic hammers.

Lomax, a pre-planned city in Henderson Co., Ill., offers some novel inducements for industrial installations. The founders have planned for shipping facilities, power, labor and living conditions. They propose to give each manufacturing plant free power for at least ninety years on the basis of one horsepower for each male employe, charging for additional power at the rate of twenty dollars per horsepower for a year. Workmen's houses will be rented on the basis of two per cent. of the actual cost and the workman will be given a chance to buy and build on small reservations without cash.

At the Liverpool Royal Infirmary recently a tube of radium, worth over 1000 pounds, which had been applied to a patient's face, was missed, and as it was proved with the X-rays that the patient had not swallowed the tube, it was conjectured that it had been swept up from the floor. A cart full of sweepings was detained just as it was about to leave the infirmary, and Professor Wilberforce, of Liverpool University, tested it with an electroscope, which indicated that the radium was in the cart. The rubbish was then placed in buckets, each of which was tested in the same way, and the tube was discoverd in the twelfth bucket.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 3.

1,085,598. OZONE-GENERATOR. William O. Freet, Hackensack, N. J.

1,085,640. CRYING DOLL. Albin Steiner, Sonneberg, Germany.

1,085,756. DEEP-WELL PUMP. Thomas O. Perry, Oak Park, Ill.

1. In a pneumatic pump, the combination with a source of compressed air and a plurality of water chambers, each having intake and outlet water valves, of an air-valve adapted to admit and release compressed air to and from said water chambers in succession, a valve-chamber inclosing said air-valve in proximity to said water-chambers, a valve actuating motor remotely placed with reference to said air-valve, an air-pipe for conducting compressed air to said valve chamber and a valve actuating shaft between said valve and said motor.

1,085,771. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,085,896. GUARD FOR PNEUMATIC HAMMERS. Harry N. Evans, Sr., Philadelphia, Pa.

1,085,926. APPARATUS FOR PRODUCING VACUUMS. John I. McCormick, Chicago, Ill.

1,085,971. METHOD OF HUMIDIFYING AIR AND CONTROLLING THE HUMIDITY AND TEMPERATURE THEREOF. Willis H. Carrier, Buffalo, N. Y.

1. The herein described method of controlling the humidity of air in an inclosure, consisting in introducing into the inclosure air which has been substantially saturated with moisture, and regulating the temperature at which the air is saturated so as to maintain a substantially fixed difference between the temperature existing in the enclosure and the temperature of the saturated air, substantially as set forth.

1,085,974. TELEPHONE SYSTEM. Elmer R. Corwin, Chicago, Ill.

1,086,089. MEANS FOR REMOVING MOISTURE FROM AIR AND GASES. Paul Schou, Copenhagen, Denmark.

1. An apparatus for absorbing water vapor from air or other gases comprising an absorbent chamber for containing a liquid absorbent, an adjacent vapor chamber adapted for the passage therethrough of air or gas containing wa-

ter vapor to be extracted, and an imperforate acid proof porous partition between said chambers adapted to pass liquid absorbent into the vapor chamber.

1,086,130. PROCESS OF WORKING WITH HYDROGEN UNDER PRESSURE. Carl Bosch, Ludwigshafen-on-the-Rhine, Germany.

1,086,222. PNEUMATIC STRIPPING MECHANISM FOR CARDING-CYLINDERS. Auguste Rouge, St.-Etienneles-Remiremont, France.

1,086,230. AIR-PUMP LUBRICATOR. George M. Schwend, Birmingham, Ala.

1,086,273. PROCESS OF PREPARING FLAX. George H. Campbell, Toronto, Ontario, Canada.

1. In the art of preparing flax, the improvement which consists in subjecting unretted flax material to the action of ozonized air within a confined space, continuing the operation until the material is retted, and then separating shive material from the fibers.

FEBRUARY 10.

1,086413. PRESSURE - REDUCING VALVE FOR AIRFEED DRILLS. Albert H. Taylor and Lewis C. Bayles, Easton, Pa.

1,086,443. PNEUMATIC - DESPATCH - TUBE APPARATUS. James T. Cowley, Boston, Mass.

1,086,550. PRESSURE-RELIEF VALVE FOR PNEUMATIC TIRES. William J. Morrison, Sioux City, Iowa.

1,086,561. AIR - CONTROL DEVICE FOR LIQUID-GASES. Oliver C. Ritz-Woller, Chicago, Ill.

1,086,591. VACUUM CLEANING APPARATUS. William H. Fulton, Brooklyn, N. Y.

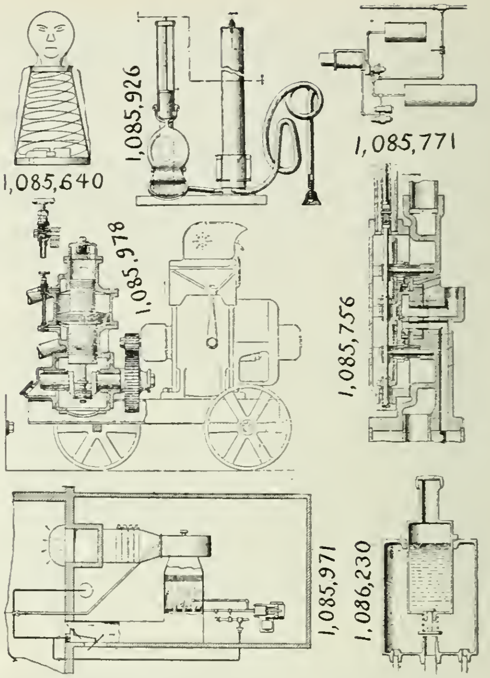
1,086,625. PNEUMATIC ROCK-DRILL. Clark J. Smith, Ottumwa, Iowa.

1,086,681. BLAST-PRESSURE-REGULATING VALVE. William Melas, Ridley Park, Pa.

1,086,686. BLOWER. Christian Neumann, St. Louis, Mo.

1,086,755. ROTARY COMPRESSOR, BLOWER, AND PUMP. Charles G. Curtis, New York, N. Y.

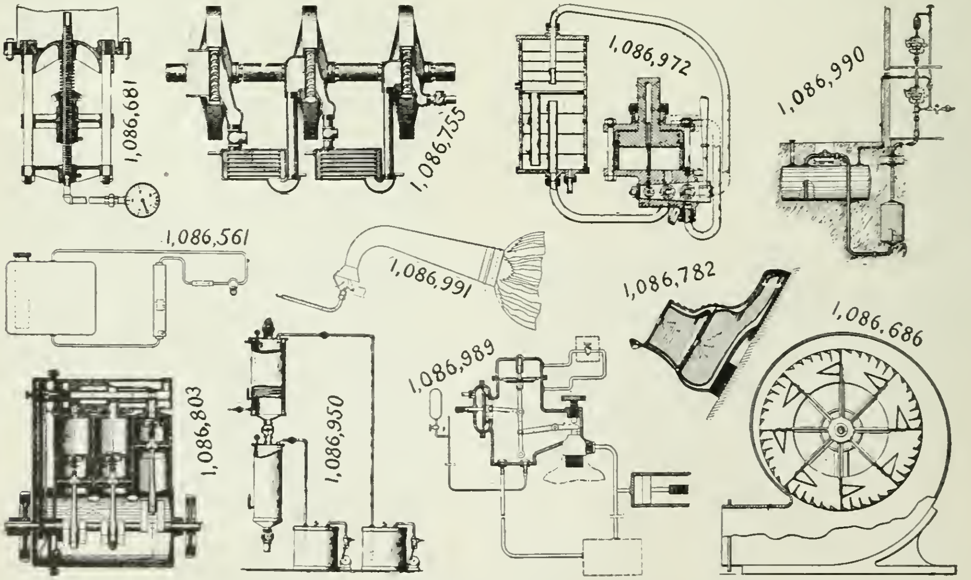
1,086,759. APPARATUS FOR PRODUCING VACUUM IN ELECTRIC LAMPS. Lloyd A. Fell, Warren, Ohio.



Pneumatic Patents February 3.

1,086,782. PNEUMATIC SHOE-FORM. Omer E. Moore, Coldwater, Kans.

1,086,803. CONVERTIBLE MOTOR AND PUMP. Charles Frank Buckland, Denver, Colo.



Pneumatic Patents February 10.

1,086,824. MOLDING APPARATUS. Maddra Jackson Hewlett and Henry L. Demmler, Kewanee, Ill.

1,086,950. PROCESS OF DRYING CORN. Chas. W. Stanton, Mobile, Ala.

1. The hereindescribed process of drying grain which consists in successively heating and cooling the grains in air-tight receptacles; and maintaining a constant high vacuum in said receptacles throughout such treatment.

1,086,955. PNEUMATIC TOOL. Edward M. Tobin, Barre, Vt.

1,086,972. APPARATUS FOR THE AERATION OF LIQUIDS. Frank Corey Yeo, Dan-y-coed, near Swansea, Wales, and Wynyard Montagu Hall and Thomas A. Goskar, Westminster, London, England.

1,086,989. MARINE SAFETY DEVICE. Maurice Bouchet, Paris, France.

1. In a safety device for ships and submarine boats, the combination of a casing, a diaphragm mounted therein, a water-tight compartment communicating with said casing, a series of levers connected with said diaphragm, a compressed air tank, a pipe leading from said compressed air tank to said water-tight compartment, means controllable by said series of levers for opening said compressed air tank, a second casing connected with said first mentioned casing, a diaphragm located in said second mentioned casing and exposed to pressure of air from said first mentioned casing, and an operative connection from said second mentioned diaphragm to said series of levers for the purpose of closing said air tank.

1,086,990. LIQUID-DISTRIBUTING APPARATUS. Augustus Bowser, Fort Wayne, Ind.

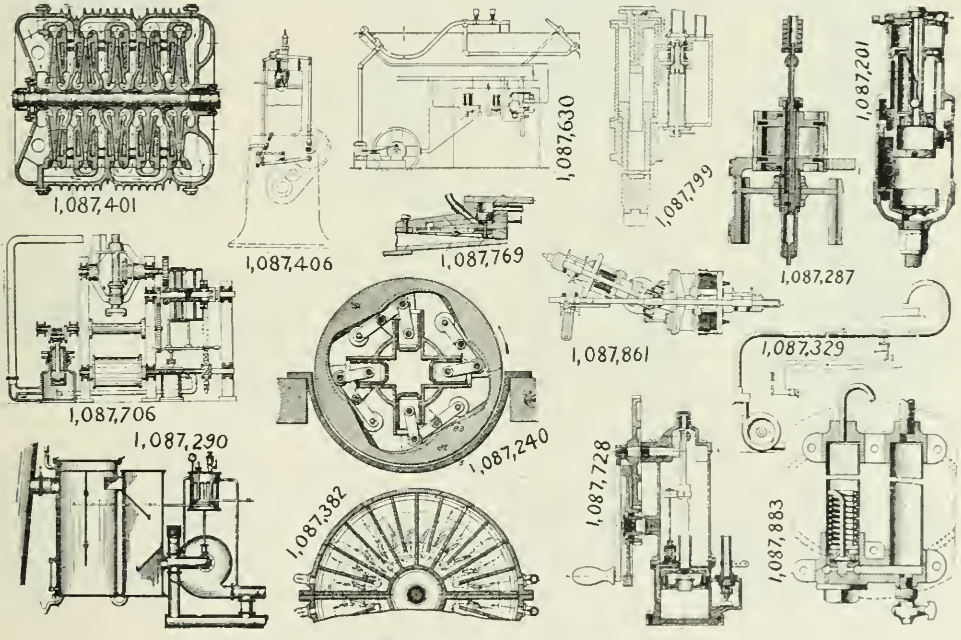
1,086,991. BUBBLE-BLOWER. Charles Vernon Boys, London, England.

1,086,998. LIQUID-FUEL BURNER. George Edmond Denman, Fruitvale, Cal.

FEBRUARY 17.

1,087,201. PUMP FOR AUTOMOBILE-TIRES. Joseph H. Templin, Philadelphia, Pa.

1,087,240. FLUID-PRESSURE ENGINE. John Kellington, New Westminster, British Columbia, Canada.



Pneumatic Patents February 17.

1,087,287. APPARATUS FOR CASTING AND BLOWING GLASS BOTTLES AND THE LIKE. Charles I. Geer, Washington, D. C.

1,087,290. APPARATUS FOR COOLING, WASHING, AND DRYING GASEOUS PRODUCTS OF COMBUSTION, AND CHARGING THE SAME WITH FUMIGANTS. George Harker, Petersham, near Sydney, New South Wales, Australia.

1,087,329. APPARATUS TO INDICATE THE STOPPAGE OF CARRIERS IN THE TRANSMISSION-TUBES OF PNEUMATIC-DESPATCH-TUBE SYSTEMS. John F. Skirrow, East Orange, N. J.

1,087,382. CENTRIFUGAL COMPRESSOR. Walter Kieser, Charlottenburg, Germany.

1,087,399. RELEASE-VALVE. Frank Phelps, Little Rock, Ark.

1,087,401. CENTRIFUGAL AIR-COMPRESSOR. Richard H. Rice, Lynn, Mass.

1,087,406. AIR STARTING MECHANISM FOR OIL-ENGINES. Leo V. Stoeltzlen, Erie, Pa.

1,087,627. MOTOR. Alfred Anderson, Chicago, Ill.

1,087,630. TIMING MECHANISM. Birney C. Batcheller, New York, N. Y.

1. In a pneumatic despatch tube system, the combination with a transit tube, of an air moving device, a motor for driving it, controlling means for said motor tending to maintain the latter in operation, and a timing mechanism comprising a driving shaft, a member normally connected to said shaft and thereby moved into and held in one position in which said member engages said controlling means and actuates the latter to stop said motor, means actuated on each insertion of a carrier in said transit tubing for temporarily disconnecting said member from said shaft at the time of said insertion, and provisions effective whenever said member and shaft are disconnected for moving said member into a second position from which it may be thereafter returned to said one position by said shaft.

1,087,632. ROCK-DRILLING MACHINE. William S. Benjamin, Seattle, Wash.

1,087,674. PNEUMATIC VALVE. Frank G. Lynde, New York, N. Y.

1,087,706. ROCK-DRILLING MACHINE. FRANZ BADE, Peine, Germany.

1,087,728. VACUUM-PUMP. PAUL COLOMBIER, Paris, France.

1,087,769. PNEUMATIC ACTION. ARVIN H. HOPPERT, Ann Arbor, Mich.

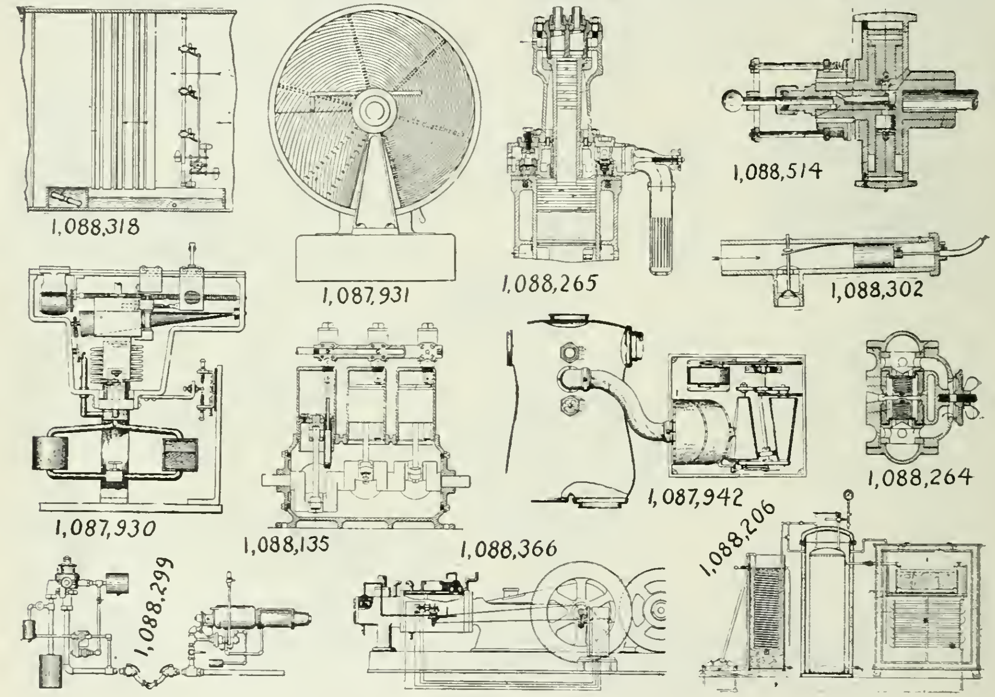
1,087,799. ELASTIC-FLUID HAMMER. LEONARD FLETCHER MASSEY and WILLIAM HENRY SNOW, Manchester, England.

1,087,861. FLUID-OPERATED ROTARY PRIME MOVER. GEORGE HENRY ALEXANDER and WILLIAM GILBERT ROBINSON, Birmingham, England.

1,087,862. AUTOMATIC COUPLING AND AIR-VALVE-OPERATING MECHANISM. ARTHUR T. AMES, Blanchard, Me.

1,087,883. PRESSURE-GAGE. OSBORN P. LOOMIS, Newport News, Va.

1,087,906. RELIEF-VALVE. CARL ROY HOUGHTON, Connersville, Ind.



Pneumatic Patents February 24.

FEBRUARY 24.

1,087,929-30-1-2. METER FOR MEASURING THE FLOW OF AN ELASTIC FLUID. AUSTIN R. DODGE, Schenectady, N. Y.

1,087,942. RESUSCITATING APPARATUS. CHARLES M. HAMMOND, Memphis, Tenn.

1,087,970. APPARATUS FOR TRAPPING SOLID PARTICLES IN SUSPENSION IN GAS-CURRENTS. THOMAS E. MURRAY, New York, N. Y.

1,087,988. PITOT PLUG FOR FLUID-METERS. LUCIAN A. SHELDON, Schenectady, N. Y.

1,087,995. ROTARY FAN. THOMAS JOSEPH STURTEVANT, Wellesley, Mass.

1,087,997. ELECTROPNEUMATIC BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,088,063. PROCESS FOR PURIFING WATER. WILHELM DRECHSLER, Dresden, Germany.

A process of purifying water, consisting in mixing the water with a weak solution of aluminum sulfate and then adding to the unfiltered water, while an *air-jet* is being introduced into the same and without waiting for the suspended particles to precipitate, a thin watery solution of permenganate of potassium.

1,088,109. PNEUMATIC-DESPATCH APPARATUS. CHARLES F. STODDARD, Rochester, N. Y.

1,088,154. TOOL FOR PNEUMATIC HAMMERS. HENRY KELLER, Chicago, Ill.

1,088,155. AIR-MOTOR. JUSTUS R. KINNEY, Boston, Mass.

1,088,206. REFRIGERATING APPARATUS. CONFUCIUS CHASE and WARREN A. CHASE, Boston, Mass.

1,088,264. VALVE MECHANISM FOR AIR-COMPRESSORS. CHARLES DAY and GEORGE E. WINDELER, Stockport, England.

1,088,265. AIR-COMPRESSOR. CHARLES DAY and GEORGE E. WINDELER, Stockport, England.

1,088,299. FLUID-PRESSURE BRAKE SYSTEM. WILLIAM H. SAUVAGE, New York, N. Y.

1,088,302. AUTOMATIC AIR-VALVE FOR GAS-MANIFOLDS. EUGENE T. SCUDDER, Newark, N. J.

1,088,306. PNEUMATIC GOVERNOR FOR MUSICAL INSTRUMENTS. WILLIAM B. TUNSTALL and ALBERT E. TUNSTALL, Worcester, Mass.

1,088,318. AIR PURIFYING AND COOLING APPARATUS. CHARLES H. BICALKY, Buffalo, N. Y.

1,088,334. ROCK-DRILL. HANS EDGAR, Karangahake, New Zealand.

1,088,366. UNLOADER FOR FLUID-COMPRESSORS. WILLIAM PRELLWITZ, Easton, Pa.

1,088,514. FLUID-CLUTCH. IRVIN E. BARRICKLOW, Antioch, Cal.

1,088,585. TURBO-COMPRESSOR. HUGO JUNKERS, Aix-la-Chapelle, Germany.

1,088,663. PNEUMATIC BULB. IRWIN F. KEPLER, Arkon, Ohio.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIX MAY, 1914 No. 5

MOISTURE IN COMPRESSED AIR

BY FRANK RICHARDS.

Users of compressed air are still constantly inquiring about the way to keep the water out of compressed air, and how to prevent the freezing up of the exhaust passages of air-operated machines. This water and freezing-up trouble began with the earliest using of compressed air, and always must be encountered if the proper arrangements are not made to avoid it. Those of long experience with compressed air have generally learned, more or less completely, what it is necessary to do in the case, but as a second or a third generation of air users is now getting into the business, it seems to be necessary to rehearse the matter again, with occasional repetitions in the future.

THERE IS NO DRY FREE AIR.

In the first place, practically nothing can be done until the air has been compressed. Carrying water is one of the principal functions of the air, and we never catch it that it does not carry more or less water vapor mixed with it. The daily reports of the weather show that humidity is the most variable of the atmospheric conditions, much more so than the temperature or the barometric pressure. But there is a lower limit of atmospheric humidity, far above the zero mark, which is never reached and seldom closely approached. When the humidity reaches 100 per cent. that becomes the "dew point," for the conditions then prevailing; the air can carry no more moisture in the form of vapor, the excess being immediately condensed into water, at first only minute globules, but still actual water.

Until the dew point is reached the air is perfectly transparent, and to the touch it is dry air; but when in the upward direction the dew point is passed, the condensed vapor is seen as mist, fog or cloud in the air, more or less dense according to the amount of water liberated, and the air in this condition will wet, or at least dampen, whatever it may happen to touch.

The reason that the atmospheric humidity reports are so constantly varying is that the moisture-carrying capacity of the air is so dependent upon two constantly varying conditions: pressure and temperature, the latter especially. So far as the pressure alone is concerned, the vapor-carrying capacity of the air is almost directly as the volume, or inversely as the absolute pressure. Thus, if air is taken into a compressor at atmospheric pressure, say 15 lb. absolute, and at 50 per cent. humidity (though it is apt to be above that) then if the air is compressed to 15 lb. gage, or two atmospheres, its humidity becomes 100 per cent., and the air can carry no more water as vapor. If the same air is compressed to 45 lb. gage, 60 lb. absolute, or four atmospheres, then one-half of the vapor is condensed into water, and so on for other pressures. If the air we started with at 50 per cent. humidity was compressed to 105 lb. gage, 120 lb. absolute, or eight atmospheres, then only one-quarter of the original moisture could remain in the air as vapor, and three-quarters of it would be condensed into water. These figures will be referred to later.

We have gone along here, as theorizers are apt to do, considering only the one condition of pressure, or corresponding volume, and entirely ignoring the temperature. We could, of course, only have realized the results above predicted if the temperature had remained constant all through, which certainly would not have been the case.

If, now, we consider the temperature alone of the air under compression, we come to results quite different, and, we may say, quite astonishing. The capacity of air for vapor of water rises rapidly with increase of temperature. The following gives approximately the weight (lb.) of aqueous vapor per pound of atmospheric air at 50 per cent. of saturation and at various temperatures:

Temp. Fahr.	Weight of Vapor per Lb. of Air.	Temp. Fahr.	Weight of Vapor per Lb. of Air.
60	0.00547	140	0.07575
80	0.01099	160	0.14776
100	0.02127	180	0.32471
120	0.04020	200	1.13400

From these figures it will be seen that it requires a rise of only a little over 20 deg. F. to double the vapor-carrying capacity of air. From 60 deg. to 200 there would be seven of these doublings, or the vapor-carrying capacity of the air would have increased from 1 to 128. The actual increase shown is 1.1340 ÷ 0.00547 = 207, but this excess is accounted for by the much more rapid rise in the last interval between 180 and 200 deg.

It is to be remembered that the above figures apply to given weights, or actual quantities of air, and not to volumes. In compressing to eight atmospheres the vapor-carrying capacity, so far as volume is concerned, is only one-eighth of what it was before the compression, but with seven doublings of vapor-carrying capacity in consequence of the rise in temperature, the air still has 128 ÷ 8 = 16 times the vapor-carrying capacity which it had before the compression began.

The case is more complicated than here outlined, because in adiabatic compression the volume during and at the completion of the compression is not reduced in proportion to the actual pressure increase; but, on the other hand, the temperatures are much higher than we have assumed, and it is evident that at the time of discharge the air must be really in a thirsty condition, although there has been no actual diminution of its vapor content.

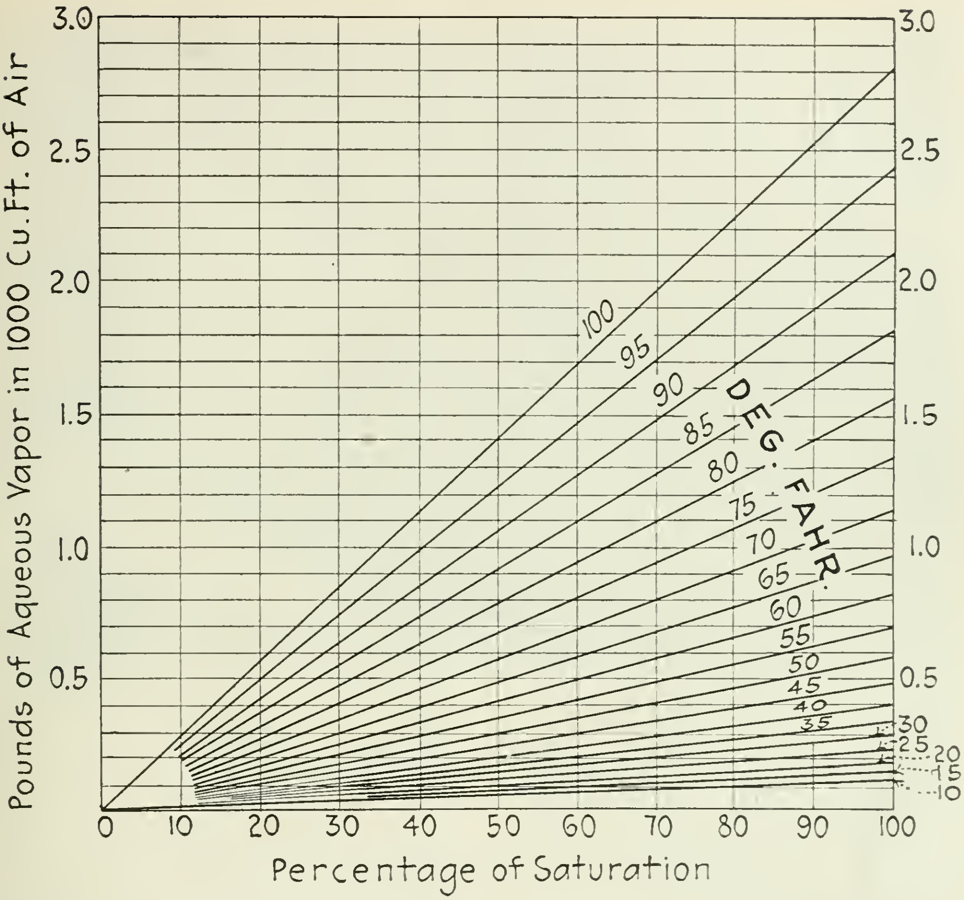
In connection with the preceding the diagram on the opposite page will be found serviceable. It shows the weights of aqueous vapor, in pounds per 1000 cu.ft. of free air, for practically the entire ordinary range of atmospheric temperatures and for different percentages of saturation, the latter being read horizontally at the bottom and the weights of water vertically at the side of the diagram. Each oblique line, or "curve," is figured for the temperature which it represents. The greater spacing for the higher temperatures, showing the increased water capacity, is quite striking. At 100 per cent. saturation, as also for any other percentage, the difference in the moisture content between 100 and 95 deg. F. is just equal to the difference between 45 and 10 deg., the latter difference being seven times as many degrees as the former. By extending the scale of temperatures upward, the differences would, of course, show much larger.

When free air is taken into a compressor at a normal temperature of, say, 60 deg., and is compressed to 105 lb. gage, the theoretical temperature is close to 500 deg., which temperature is much lowered if the compression be in two stages with efficient intercooling. If there is no aftercooler, it is doing well if the air is delivered at a temperature not above 200 deg.

The air now is no condition to give up any of its moisture, and with the air receiver located near the compressor, the air is only slightly cooled, if at all, in passing through the receiver. There are those who continue to expect otherwise, but they are continually disappointed.

THE COOLING OF THE AIR.

If, however, the air after leaving the receiver is transmitted through suitable pipes to a considerable distance, as it usually is, it is almost certain to be cooled to about normal temperature. The specific heat of air is low, so that when its temperature is high to the senses or to the thermometer it represents little in actual heat units, and has little heat to surrender to its surroundings, even when cooling rapidly. With the air thus cooled in the pipes, both the conditions of high pressure and of low temperature will be the best possible for the condensation and release of the greatest possible amount of water vapor. With the temperature of the air the same as it was before the compression began, the temperature will no longer have any effect in increasing the vapor-carrying capacity, and with the volume of the air reduced to one-eighth of what it was at the beginning, its vapor capacity will be only one-eighth of what it was. If the air when taken in is at the point of saturation, or 100 per cent. humidity, then if the air is compressed to one-eighth the volume, seven-eighths of the vapor can no longer be carried



as vapor. If the air was taken in at 50 per cent. of saturation, then only one-quarter of the original vapor can be carried as such, and three-quarters of the vapor will be condensed, and so on for other pressures.

DRAINING OFF CONDENSED VAPOR.

When the saturation point is reached and passed, in consequence of a change in the combination of volume and temperature, the one being increased or the other reduced, then the air at once unerringly gives up all the surplus of vapor beyond what it can carry. That is, the vapor is condensed into liquid globules, but unless something more is done about it, the moisture will still remain in the air, though in the liquid instead of the gaseous state. At the point of saturation, if the pressure were diminished or the temperature increased, some of the liquid would be vaporized again and become an intimate part of the air as before. If the conditions were reversed, the pressure being increased or the temperature reduced, more of the vapor would be condensed and the proportion of vapor remaining as part of the air would be reduced. On a summer day one may watch the clouds forming or gradually disappearing before his eyes as minute changes of pressure or of temperature occur.

The water condensed from vapor in the air, but still remaining in it in the liquefied condition, seems to be ready enough to get out of the air if given the opportunity. If compressed air just delivered from a compressor with an aftercooler, and thus overloaded with condensed moisture, could be kept in a mass in a quiescent state, the water would slowly go to the bottom of the containing vessel; but it has no time to stop when passing through an ordinary receiver. If the air is in motion the liberated moisture it contains will wet and cling to whatever the air touches.

If the air in this super-saturated condition, due to high pressure and low temperature, is passed through a steam separator, of any of the types of proved efficiency, the entrained water will be taken out of the air just as it is taken out of wet steam. As wet air flows along in a pipe line, the inner surface of the pipe will be wet, the water will trickle down the sides and flow along in a stream at the bottom. If there are low places in the line, and if pockets or settling chambers are provided at these points, the water will accumulate there and can be drawn off at intervals. If the water is not thus drawn off, it must be carried along bodily by the air at last into the drills, pneumatic hammers or other tools, and the neglect to drain off the water before the air comes to the point where it is to be used is the cause of most of the trouble of which complaint is made.

It is a natural and proper inference from the preceding that the higher the transmission pressure of the air, the greater will be the opportunity of draining it of moisture, and if the opportunity is taken advantage of, the less will be the possibility of trouble in the subsequent use of the air. With a system calling for comparatively low-pressure air, with single-stage compression and without aftercooler or separator or any provision for taking the water out of the pipes, the water will not allow itself to be ignored when it comes to the exhaust passages.

REHEATING COMPRESSED AIR.

Nothing probably needs to be said of the theoretical economy and advantage of reheating compressed air before putting it to use. By reheating, the working volume of the air may be quite materially increased at slight cost and the freezing-up trouble may be annihilated. It must be remembered, however, that practically little reheating has been or is being done. For driving tools or machines which are only operated intermittently, and which have no fixed position, reheating of the air is not practicable and costs more than it is worth, but for the driving of pumps or for any other constant employment, the air should always be reheated as closely as possible to the work.—*Power.*

JACKHAMERS IN SHAFT SINKING

An interesting job of shaft sinking for the Dakota Continental Copper Company is now in progress at Hill City, S. D. For the information following concerning it we are indebted to Mr. W. J. Booth, Manager.

The shaft measures 7 by 18 feet before the timbering is put in. It is timbered into three compartments; two for hoisting and the third a pipe and man-way. The shaft is very wet, so that water is pumped at the rate of 200 gallons per minute, night and day.

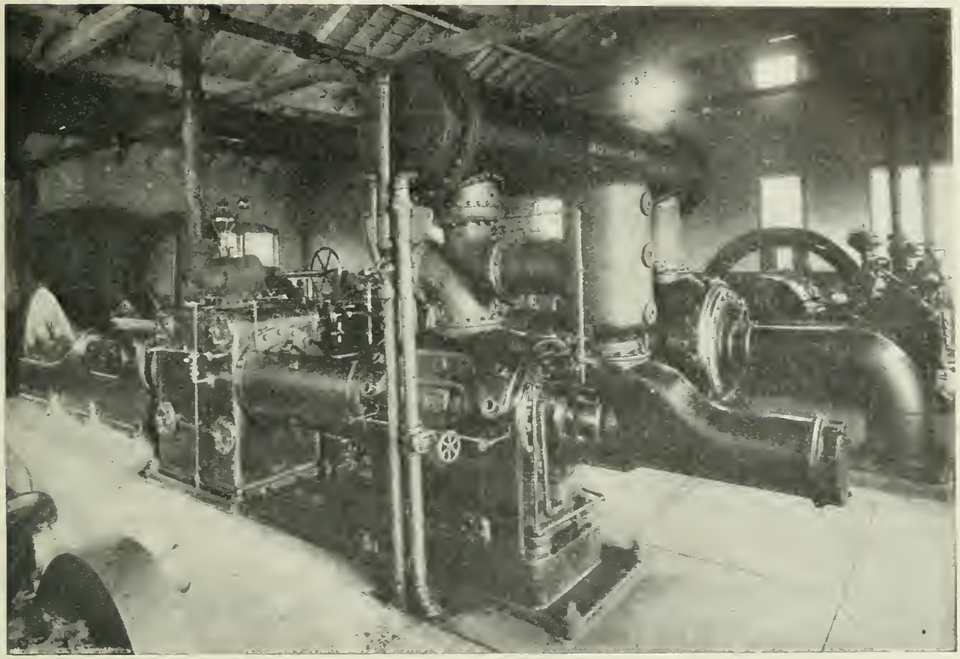
Three eight hour shifts are run, with four men in the bottom of the shaft at a time, each of these operating a Jackhamer drill when not mucking out. The muck is lifted from the bottom in 1800 lb. buckets by a double reel steam hoisting engine capable of lifting 6 tons 1200 ft. per minute.

We have, our account continues, no way of comparing the Jackhamer with hand work, but we had considerable experience with piston drills on the job. The conditions now are practically the same as with the piston drills but we have found that using the Jackhamer we are able to sink just twice as fast. We are averaging 1¼ ft. per day, this including timbering and piping.

Our rock is extremely hard, with stringers of almost pure iron running through which will give any machine plenty of grief, but we have demonstrated that even under adverse circumstances the Jackhamers, with the same number of men, do faster work than the piston drills.

Our greatest difficulty we found in drilling the out-holes, which nearly always had to be started under water, and this allowed loose rock and drillings to wash into the hole and clog the drill. We obviated this by putting a piece of 2½ in. pipe about 1 ft. long into the collar of the hole and wrapping a gunny sack around it; then by using a blow-pipe frequently we were able to put down 6 ft. holes without very much trouble.

We are running with a compressor 20 and 20 and 20x24. We are not able to state just the amount of air the four Jackhamers are using because the same compressor is furnishing air for a No. 9-B Cameron Sinker. The four Jackhamers take less air than the two piston drills, because it takes two cords of wood less to run the compressor.



COMPRESSOR AT NO. 5 COLLIERY, LEHIGH AND WILKESBARRE COAL CO.

SOME EFFICIENT AIR COMPRESSING PLANTS AT COAL MINES

BY S. W. SYMONS.

Economy in the operation of machinery, like the cost of living, is rather more a question of ratios than one of absolute values. The cycle of operations in the compressed-air mining installation is so long and complex from the combustion of the fuel in the boiler furnace to the coal cutting or pumping at the working face, that from the thermodynamic standpoint no figures of high efficiency can possibly be secured.

In spite of the many losses which the ingenuity of man has never succeeded in stopping, there are numerous others which are capable of elimination either in total or in part. That installation, then, which cuts down these needless wastes to a minimum may, by comparison with other plants erected for the same purpose, be justly and rightly termed economical. It is the purpose of this article to describe four plants coming under this category which are in successful daily operation in the anthracite-coal region of Pennsylvania.

At the No. 5 colliery of the Lehigh & Wilkes-Barre Coal Co., at South Wilkes-Barre, Penn., air has been supplied for the last 8 years by an Ingersoll-Sergeant duplex compressor. This machine is provided with simple Meyer valve steam cylinders and two-stage air cylinders compressing to 100 lb. It has been kept running 24 hours a day since installation, and is now being rebuilt preparatory to being put again into regular service.

A new compressor, shown above, which was installed a year ago, was built by the Ingersoll-Rand Co. It is of the duplex type with Corliss steam cylinders 28 and 42 in. in diameter, hurricane inlet air cylinders 37¼ and 22¼ in. in diameter, respectively, while the common stroke is 36 in. The capacity at 100 r.p.m. is 4,206 cu. ft. of free air per minute compressed to 100 lb.

The steam cylinders are fitted with a type of Corliss valve-gear, claimed by the makers to be highly efficient and nearly silent. This latter claim is well borne out by the smooth, quiet running of the machine, the only noticeable sound being the slight clicking of the relief gear and the sucking of the dash pot. The crank end of this machine, being wholly inclosed, provides a reservoir for a continuous oiling system for all the bearings except the valve-gear.

Hurricane piston inlet valves are used on both air cylinders, the intake air coming through a conduit under the engine room floor to the hollow piston rod of the low pressure cylinder. The discharge valves are of the simple poppet type.

The air upon leaving the low-pressure cylinder passes through an intercooler of the usual surface condenser construction, from whence it passes through a trap in which the moisture which has condensed in the intercooler, is caught on baffles and drained into a small tank placed on the foundation. The amount of moisture drained from the air by this device will depend on the percentage of saturation of the air before entering the compressor and the temperature at which it leaves the intercooler.

It has been demonstrated that the capacity of air to absorb moisture increases directly with the volume, regardless of pressure, and that it practically doubles with every 20 deg. F. increase in temperature.

To take for illustration an actual case, in order to show the efficiency of the device, a two-stage compressor designed for 90-lb. terminal pressure at sea level will carry about 27 lb. gage, or nearly three atmospheres absolute in the inter-cooler. This will give a temperature of about 240 deg. F. on leaving the low-pressure cylinder, if the intake temperature were 60 deg.

Assuming that the air on entering the compressor is in a saturated condition, the fact that its volume has been reduced by compression to nearly one-third would mean that nearly two-thirds of this moisture would be precipitated, provided the temperature was reduced in the intercooler to 60 deg.

This is wherein lies the usefulness of the intercooler. But although this amount of moisture is given up by the air, it is not precipitated, but the greater part hangs in the air in the form of a mist, and in the average installation is carried over into the high-pressure cylinder, where it is again taken up by the air, owing to the heat of compression, thus causing a loss of power, besides trouble in the pipe line and at the points where the air is used. With the form of trap just described, nearly all of this moisture is caught and drained off.

Of course, the ideal conditions would be to extract all of this moisture before the air enters the compressor. This, however, would be impossible without a refrigerating plant. Much can be done, however, by taking the air from the coolest point possible, not from the inside of the engine room, or by installing some form of pre-cooler, which might be so designed as to clean the air as well as lower its temperature.

A UNIQUE AIR CLEANER.

A unique form of air cleaner is placed on the inlet to this machine. This is constructed of concrete and consists of a pit or box a little below the level of the engine room. A cover is placed over this box provided with openings so screened as to exclude large particles of foreign matter. The bottom of this chamber is filled with a heavy oil, just above the surface of which is placed a horizontal pipe provided with a long slot on the under side with one end closed and the other connected with the compressor intake conduit.

The air in passing to the compressor suction impinges more or less on the oil in the basin, leaving behind much dust and grit which would otherwise be carried over into the machine to the detriment of the valves and pistons. The oil can be easily removed and renewed as found necessary.

The use of this cleaner is of great benefit to the proper working of the compressor, and credit is due to the Lehigh & Wilkes-Barre Co. therefor, the device having been constructed by their engineers. It is, of course, impossible to put down in figures the saving realized by such an apparatus, its operation being in the nature of a preventive rather than a cure. Some such cleaning device should, however, form a part of every up-to-date compressor installation.

The air from this machine is used to operate underground hoisting engines during the day, and at night a single pump for unwatering the mine, which takes the full capacity of the compressor, is operated.

LITTLE STEAM USED.

The engineer in charge made the assertion that his compressor used little if any more steam than the older machine of about one-half its capacity; and this in spite of the fact that the steam pressure fluctuates anywhere between 80 and 100 lb., so that the engine at times runs practically without cutoff.

A compressor of the same type but slightly smaller, was installed two years ago at the plant of the Kingston Coal Co., at Kingston, Penn., to take the place of two straight-line tandem-compound compressors with a combined capacity of 5,000 cu. ft., which were installed some years before.

The new machine has a rated capacity of 3,336 cu. ft. at 120 r.p.m., compressing to 100 lb. It easily takes care of this load, but owing to the increased use of air in the mine, another compressor of the same type and design is to be installed.

A BATTERY OF RECEIVERS.

The air is piped to a battery of receivers, consisting of three 42-in. by 34-ft. cylindrical tanks coupled together. It is led in at the top to a pipe connection in the center of the battery. Provision is made for the new compressor when installed at the other end of the system.

This air-storage system was installed by the coal company to take care of the fluctuations of the load, and worked out well in practice. The air is used for pumps and hoisting engines underground.

This compressor is installed beneath a coal breaker, and consequently under unfavorable conditions, the intake being only protected by wire screens. In spite of this fact, however, it has not been necessary to renew any of the air-inlet valves or valve springs since installation. The machine runs 24 hours per day, and has been speeded up to 125 r.p.m. for hours at a time.

At the Gaylord mine of the Kingston Coal Co., at Plymouth, Penn., another machine of the same type is installed chiefly for operating the mine hoist. This compressor has a capacity of 2000 cu. ft. at 134 r.p.m., and runs so smoothly that the writer was able to balance a nickel on edge on top of the main frame, while the machine was operating at 125 r.p.m. This compressor takes the place of an old Ingersoll-Seargent straight-line machine.

At the Plymouth Coal Co.'s Dodson mine, also in Plymouth, Penn., a compressor of the same size and type as that installed at the Kingston plant was put in to take the place of a 10-year-old duplex machine, a relic of former days. This compressor has run constantly for the last year and a half, generally being speeded up to about 125 r.p.m., or 750 ft. piston speed.

This compressor, about a year ago, was put to a rather unusual use. Fire had broken out in the workings, and it was found to be impossible to get any fire-fighting apparatus within reach of the flames, owing to the noxious gases present. This difficulty was overcome by directing the full capacity of the compressing plant, which includes a small straight-line machine, besides that above mentioned, into the workings and forcing the gases back until the fire-fighters were enabled to get near enough to extinguish the fire.

In all of the above mentioned plants, the steam pressure fluctuates considerably. This does not, however, appear to interfere with the proper operation of the Corliss compressors, but makes it impossible to obtain any actual record of economy.—*Coal Age.*

HAMMER DRILLS ON HIGHWAY WORK

The construction of road 5266 of the New York State highway system in Jefferson County requires the excavation of about 5000 cu. yd. of rock in what is known locally as the Depauville cut. At this point the road, which is of water-bound macadam, passes over Graber Hill, the grade formerly being 10 to 12 per cent., but by making a cut of more than 25 ft. at its maximum depth the grade was reduced to approximately 4 per cent. The soil of Graber Hill is underlaid at a depth of about 2 ft. with a 7-ft. stratum of gray limestone. The limestone is unusually hard and tough and is interlaid at intervals of approximately 1 ft. with seams of hard clay from ½ to 3 in. in thickness. The removal of the limestone by ordinary methods was found to be exceedingly difficult.

A tripod drill operated in connection with a stationary steam plant was first tried by the contractor, but with poor results. The seaminess of the rock interferred with drilling by causing the drills to bind, necessitating more frequent blasting. This necessarily slowed up the work and made it more costly, as more powder had to be used and the drilling equipment had to be removed and reset more often. Looking for a solution of the problem the contractor experimented with hammer drills operated by compressed air. The result was considered satisfactory from both operating and cost points of view.

While hammer drills are in general use in mining operations, their adaptability to road work is not widely known among highway contractors and engineers. The drill employed on this work was a large type of the common hand drill and used a hollow steel of hexagonal shape through which air was discharged for the purpose of removing the dust and stone cuttings under the bit of the steel. The contractor reports that he has since used an automatically rotating drill in similar rock work with even better results.

Although the average depth of the holes was about 8 ft., holes were occasionally drilled to as great a depth as 12 ft. in sound stone without the binding action being noticeable. A short steel or starter, from 1 to 1½ ft. long, was first used with a bit considerably larger in diameter than the steel itself. Successive steels, each about 1 ft. longer than the preceding, and each with a bit slighly smaller in diameter, were used until the desired depth was reached. In the early operations with the tripod drill the bit had frequently been forced through thin layers of rock under the action of the heavy blows to which the drill was subjected in much the same manner as an auger penetrates a thin piece of wood. This tended to reduce the diametral dimensions of the hole, make it irregular in shape and bind the drill. The lighter and more frequent blows of the hammer drill, which is dependent on its own weight and not on forced cranking for its feed, gave it a tendency to rebound and eliminated the binding action when penetrating alternating hard and soft strata.

Another advantage observed was the ease in setting up. Very little time was required to move from one point to another and as much as 240 ft. were drilled by two hammer drills, each operated by one man, in a day. Where a hole close to the embankment was necessary to distribute the shot properly, the hand drill could be started with no more preliminary trouble than if the shot was to be placed in the center of the cut. There were no limitations in its use as to inclination of hole, but a maximum depth attainable with only one drill operator was 12 ft. A greater footage of holes was drilled with the hammer drill than was economically possible by the other methods, and with a greater number of holes the rock was broken into smaller pieces and of better size for removal in dump carts.

The hammer drill was connected to an Abenaque portable air compressor outfit which comprised a 20-hp. horizontal, four-cycle, gasoline engine mounted on a steel frame and direct-connected to an Ingersoll-Rand air compressor. The whole was mounted on wheels and followed closely the work of the drillers as they progressed through the cut. When not in use on the drilling work the outfit was moved to a nearby rock crusher, the compressor disconnected, and the engine belted over a friction clutch pully to the crusher and employed in breaking the rock used in the foundations for the macadam construction.

Water for the work had to be drawn in tanks from Depauville, 2 miles distant. A saving in cost of this account was noticeable as compared with steam-operated drills, as the outfit required only 2 bbl. of water a week for use in the cooling system of the engine. Approximately 18 gal. of gasoline were required for one ten-hour day run. The work was done by Coleman Brothers, General contractors, of Boston, Mass.— *Eng. Record.*

CONTRIBUTORY NEGLIGENCE

In a personal injury case, the plaintiff, who had been cleaning the flues of a boiler, was injured by the unexpected starting of a rotary motor, driven by compressed air, caused by the opening of a lever valve in a double connection attached to a movable hose. The jury returned a verdict for the plaintiff, and found specially that the defendant's negligence consisted in using a valve without a locking or safety device, and that they did not know what caused the valve to open. On appeal it was held that the fact that a screw valve was provided at another point by which the plaintiff could have cut off the compressed air was not fatal to his right to recover, since to have used that valve would have cut the air off from another machine as well as from that which he was using. Although the jury were unable to say in what manner the valve was opened, their verdict was sustained on the ground that it was a fair question for their determination whether, under all the conditions shown, it was negligence to use a lever valve without a locking device in a situation such that it might in various ways be accidentally opened.

Wells v. Swift & Co., Kansas Supreme Court, 133 Pac. 732.

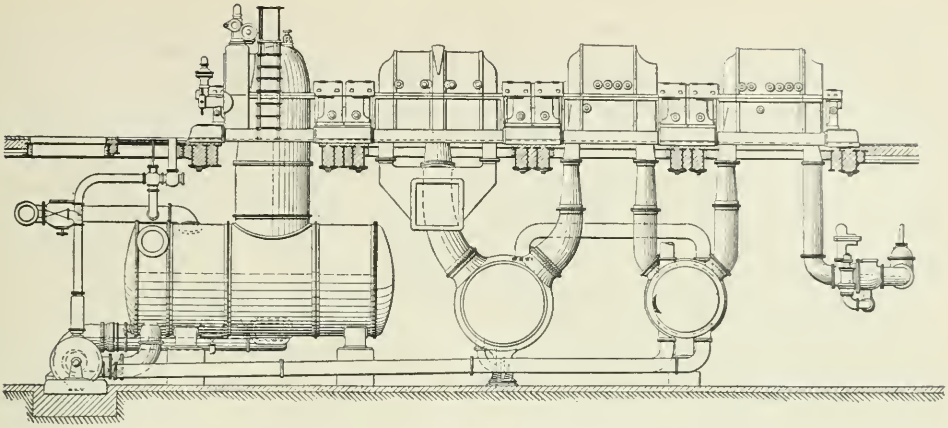


FIG. 1

A LARGE TURBO-COMPRESSOR

BY DR. ALFRED GRADENWITZ.

A short time ago a remarkable turbo-compressor was completed at the Allgemeine Elektricitäts Gesellschaft turbine factory, with a capacity of 3,531,400 cu. ft. of free air per hour compressed to 140-170 lb. per sq. in. This corresponds to a power output of 12,000-13,000 b. h. p.

This is one of three compressors of the same capacity to be supplied to the Victoria Falls & Transvaal Power Co. This company was the first to avail itself of the advantages afforded by turbo-compressors of large size and to adopt the transmission of power on a large scale by the agency of compressed air. The company already has twelve 4000 h. p. turbo-compressors in commission in its power stations near Johannesburg. The compressed air from these machines is transmitted through a pipe line 18.6 miles long, supplying 17 mines for operating rock drills and other air operated tools. The installation of the three large compressors will raise the total amount of energy transmitted by the compressed air to 84,000 h. p.

Fig. 1 shows the general arrangement of the compressor here spoken of. The steam turbine is on the left hand side. This is designed for high pressure, superheated steam, and is fitted with automatic nozzle regulation. This is understood to be the first turbine built to give an output of 12,000 h. p. at a speed of 3000 r.p.m.

The compressor, consisting of three cylin-

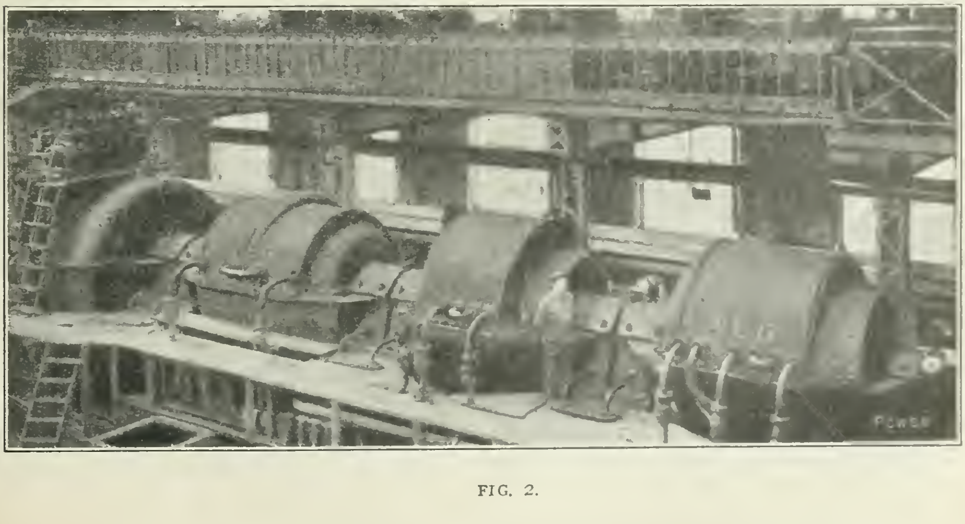


FIG. 2.

ders, is connected to the steam turbine by a flexible coupling. The low-pressure air cylinder is next to the turbine, and in view of the large quantity of air handled, is designed to draw in air on both sides. The air passes from the main suction pipe, the square section of which is visible in Figs. 1 and 2, into the two ends of the low-pressure compressor, passing out to the intermediate cooler, slightly compressed at a temperature of about 100 deg. C., in which it is cooled to about 30 deg. C.

The intermediate cylinder, through which the air next passes, is constructed with an intake on one side only, as the volume of air has been so reduced that it is no longer necessary to divide the air current on account of the suction of the impellers The air compression is further increased in this cylinder, and the air passes out of it in a highly heated condition, to be coooled again in a second cooler, Fig. 1, whereupon it enters the high-pressure cylinder for final compression and is then discharged to the pipe line through the pressure pipe shown in Fig. 1, on the right.

As the cooling effect in the intermediate coolers is not sufficient to permit the process of compression to be carried out economically, the compressor cylinders themselves are water cooled. The pipe lines through which this water is brought is shown in Fig. 2, which is a view of the compressor on the test bed.

The light foundations upon which the turbo-compressor is erected are especially noteworthy. They permit the intermediate coolers with their piping and the condenser plant for the turbine to be installed conveniently below them in the basement.

This first 12,000-hp. compressor, on test, satisfied the guarantee conditions for steam consumption, which were more severe than would have been thought possible for units of 1000 to 2000 hp. The units ran on the test bed for several hours with a load up to 12,000 hp., corresponding to normal working conditions.—*Power.*

ROCK DRILLING IN LAKE SUPERIOR IRON MINES

BY P. B. MC DONALD.

The present status of the rock drill in the Lake Superior iron mines is much different from that of a few years ago when nearly all drilling was by the two-man, mounted, reciprocating machine. The stope drill is now used for practically all the raise work requiring a power drill. The cost of raising has been generally reduced to less than half the former cost. It is probable that the stope drill has worked greater economies than any other type. On account of the mass-like shape of the large iron ore deposits, raising is an important part of many of the mining methods in vogue.

The one-man, mounted, reciprocating drill for driving and stoping (over which there was so much controversy in the copper country) has had a number of sales in the iron region, and was an efficient drill for the "medium soft" grades of ore. It was repeatedly demonstrated that one man could accomplish the same (or greater) drilling results with this drill as previously had required two men with the old type, heavy drill. However, a new development has taken place in this line in the iron region. Unlike the tough copper country rock, the majority of the iron ore is medium soft or soft, some of the latter varieties on the Mesabi range having been drilled with hand augers for years. It has been found that a small, automatically rotated, "plug" drill, changed so as also to be used as a power auger, is possible; that is, such a machine will work as an auger in soft ground but when a hard seam is struck it changes to a hammer drill. This new style of drill promises to be a decided success, and is expected ultimately almost to replace the one-man piston drill in the iron mines.

The general use of smaller and lighter drills in driving and sinking is resulting in a trend to the European practice of shorter holes, better placed, and a shorter cut; it is found that with cuts of 4 or 5 ft. progress can be made faster than was formerly possible with 6-ft. cuts; the light drills permit greater flexibility in pointing the holes, and can be quickly moved back out of the way for blasting, thus encouraging more frequent blasting.

[This reference to European practice is scarcely applicable as that has to do with tunnel work, which is essentially different from mining.]

For drilling the unusually hard ores and for the hard rock sometimes accompanying the iron ores, such as jaspilite and quartzite, the two-man, reciprocating drill will be retained. Another type of drill which has been successful in the hard rock (more especially true in the copper country) is the Leyner drill. This can perhaps be called a hybrid type because it is a hammer drill and at the same time is mounted on bar or tripod; the water principle of washing out rock chippings is, of course, an important feature.

In sinking, a radical change has come about. In place of the two-man, piston drill on tripod or bar, little "plug" drills are now used. Three-quarters of the shaft sinking in the iron region is now done by automatically rotated plug drills or "hand sinkers," and records are being made in speed of sinking.

On the Gogebic range, the Newport Mining Co. recently sunk an 11 by 18 shaft in quartzite 33 ft. in one week, with Jackhamers, and the concrete lining was put in at equal speed. Contrary to first expectations these little hand sinkers can put down deep holes when necessary. Their principal advantages lie in their one-man principle, enabling twice the number of drills to be used in a shaft, and in the ease with which they can be removed for blasting. —*Mining and Scientific Press.*

PRACTICAL NOTES ON THE PULP-AIR-LIFT

BY A. M. MERTON.

Not long ago a well-known practical mill man, who was being shown around a mill, then in course of erection, commented on the air-lifts. His advice was to discard them, and replace by some kind of pump or elevator. His own experience has been unfavorable. The man who was to take charge of the mill, as foreman, was also dubious; the experience he had had with them, working under another engineer, was not satisfactory.

Again, in one of the most up-to-date mills on the continent—one in which the practice was carefully worked out by several years' preliminary work on a smaller mill—the air-lift is conspicuous by its absence. All wet pulp is raised by bucket-elevator. These brief statements outline the general attitude towards air-lifts. Some engineers are more than a little afraid of them. It is, however, interesting to note that in the mill first referred to, the air-lift worked most successfully, and that, in the latter, a modification in the treatment required elevation of the pulp in a part of the mill where no provision was made for such elevation; an air-lift was tried out and worked so successfully and economically that the present intention is to replace the bucket-elevator by air-lift wherever possible.

There have been many failures in the use of air-lifts for elevating pulp. Nothing is heard of these failures, owing to the fact that most of them were on a small or experimental scale. It is clear, then, that the principles on which the pulp-air-lift works are not well, or generally understood. The practice in lifting pulp differs in certain particulars from the air-lift which merely raises water. The failures are due to not appreciating these differences.

In regard to the principles on which air-lifts work there is still a general misapprehension among mill men. Many believe that the liquid is raised in the lift pipe by the medium of "pistons" of air thrusting the fluid upwards. In a properly designed and operated air-lift, this is incorrect. In a well-arranged lift the flow of pulp is steady and even, showing that pistons of air do not occur. When the pulp is delivered in spurts, the air-lift is working inefficiently.

The air-lift merely works on the principle of the hydrostatic balance; the fluid in one limb being lightened by the introduction of air. For example, take a U tube, Fig. 1, 4 ins. in diameter, with one limb 24 ft. long, and the other 36 ft.; it will hold about 4 cu. ft. above the bend. Now into the long limb of the U tube pass a stream of air bubbles, so that at all times there is one cu. ft. of air in it. Each sphere of air will displace an equivalent volume of water, and of course the water will rise in the long limb until the volume is that

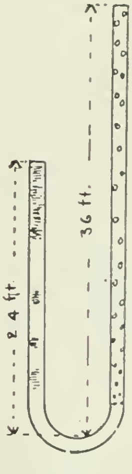


FIG. 1.

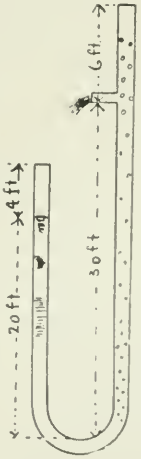


FIG. 2.

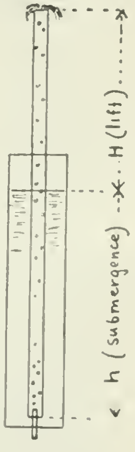


FIG. 3.

of the combined air and water; or in this case it will rise 12 ft. without in any way affecting the water level in the short limb. Thus we see that 24 ft. of water will balance 36 ft. of an aerated fluid containing 30 per cent. of air by volume. Now if the long limb is cut 6 ft. below the top of the pipe, Fig. 2, the water will flow out under a head of 6 ft. (or with an initial pressure of about one-fifth pound per square inch in this case) until the level stands 4 ft. lower in the short limb, when the flow will cease. Thus we have again 20 ft. of water balancing 30 ft. of mixed water and air, and if the short limb is continuously supplied with water, the longer limb will have a steady stream of water issuing from it. There is no necessity whatever to assume the presence of air pistons. The little bubbles of air displacing an equivalent volume of water are not only sufficient to do the work, but experience has shown that they act more economically than the pistons.

All this is rudimentary, but it must be understood, if clear ideas are to be held regarding air lifts. But in air lifts for elevating pulp, other questions have to be considered To neglect these questions is to invite failure.

Pulp is a mixture of sand, clay and water, or cyanide solution. It is clear that, in raising such a mixture, the velocity upwards must be great enough to lift the coarsest particles in the pulp. Otherwise there will be a sorting action in the lift—the lighter particles being carried upwards and the coarser left behind—and the gradual accumulation at the bottom of the pipe will eventually choke it.

The operation of an air-lift discloses the fact that the screens and classifiers of a mill allow, in some manner, the escape of a very small percentage of very coarse particles. For instance, in one plant treating 4,500 tons of slime a month, 80 per cent. of the slime passing a 150-mesh screen, there accummulated, in one part of the system, about 1,000 lbs, of coarse ore every month. Or at least that amount was removed. There was reason to believe that the actual amount present was greater. The particles varied in size from rice, to a small bean. Screen analyses never detected their presence.

In considering air-lifts, therefore, the upward velocity of the current must be great enough to carry off very large pieces of ore, otherwise the air-lift will give periodical trouble by choking. Considerable experience with air-lifts has shown that the velocity of the pulp in the rising limb must not be less than 2½ ft. per second and that to get good results 5 ft. per second would be better.

In every case of a failure of which I have any specific knowledge, the fault has been in having too large a rising pipe. A large pipe, in carrying water, of course, means a low loss by friction; but it also means a low velocity of water in the pipe. In an air-lift elevating pulp, the velocity upwards is fixed by the character of the pulp and cannot be reduced. The loss due to friction cannot be eliminated

The next error is in providing insufficient air to properly operate the lift. Mechanically the air-lift is most inefficient. Generally 3 times as much air is required to raise a given quantity than is theoretically necessary. It is safe to say that twice the amount of air is required to lift a mill pulp than the tables give for lifting an equivalent amount of water. Of course, it is to be understood that these statements are approximations.

REQUIREMENTS OF AN AIR-LIFT.

Turning now from general considerations, let us consider the specific requirements of an economical air-lift:

Usually the air-lift takes the form of 2 tubes, one within the other. The outer pipe acts as a well, while the smaller inner pipe acts as the riser, and takes the place of the long limb in the U-tube. In the diagram (Fig. 3) *H* is the height of lift; *h* is the feet of submergence; *H* plus *h* is the total length of the riser. It has been found by experience that *h* should be at least 60 per cent. of the quantity *H* plus *h*, to get economical results. In actual mill work it can be as low as 45 per cent.

The air pressure required is calculated from the formula:

P=pressure;
S.G.=specific gravity of pulp;
h=submersion.

P=433. S.G., h.

Actually a few pounds extra pressure are required to overcome friction, say from 3 to 4 lbs.

The amount of air required depends upon the design of the lift and the percentage of submersion. Too few data are at hand to safely theorize upon this matter. Actual test has shown that 2.5 cu. ft. of free air per cubic foot of pulp to be raised is the least that should be provided. In a specific case 3.2 cu.

ft. air were required to raise 1 cu. ft. of a pulp containing 28 per cent. solids. For a new plant where actual data are wanting it is safe to say that a compressor capacity of 3.5 cu. ft. of free air by piston displacement per cubic foot of pulp to be raised is the least that should be provided.

In selecting a compressor it is a mistake to have too high a pressure. If the requirements are for 20 lbs. pressure, the delivery of air at 30 lbs. is mere waste of power. It has been said that an air-receiver is not necessary. This may be so, theoretically. Still a large receiver is necessary when the air is being used for a great variety of purposes. Also, practically, it acts as an oil trap, the value of which, in a cyanide or concentration plant, cannot be gainsaid. There are air-cooled compressors on the market for low-pressure air. These have been used with satisfaction, but often they consume too much oil to be good machines for metallurgical purposes.

Lastly, in considering mill work it should be remembered that the requirements for economy cannot be strictly followed. Where there are a number of lifts, agitators, etc., to be operated from the same compressor, the requirements of each must be different. Thus one may only require 10 lbs. pressure while another may demand 28 lbs.

The efficiency of air-lifts has been reckoned to be from 40 to 50 per cent. In actual practice the economy can only be reckoned as about 35 per cent. Especially where many lifts working under different heads are joined up to the same compressor.

However, in spite of the low mechanical efficiency, the absence of moving parts, the cheapness of the material used, and the compactness of the apparatus all make the well-designed air-lift the most economical means of lifting pulp that we now have.

The actual design and construction of an air-lift should be as simple as possible. Elaborate designs for maintaining a uniform submergence, by regulating the air inlet by means of floats, etc., are valueless. They may be, indeed, a detriment. Complicated foot-valves for delivery of the air at the bottom of the riser, are also not only unnecessary, but frequently are a nuisance.

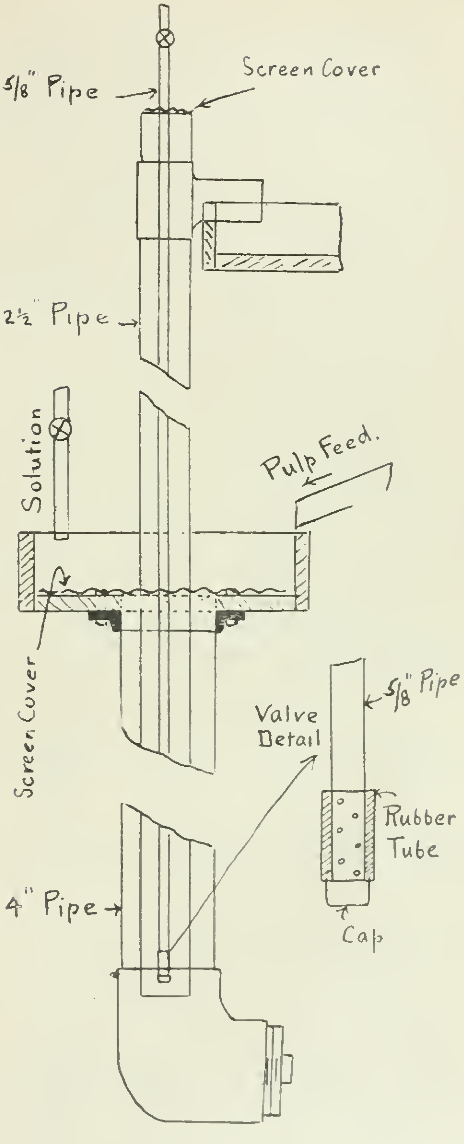


FIG. 4.

So far as the air-jet is concerned, it may simply be formed by the open end of the pipe looking downwards. Where the attempt is made to use the air as a jet, as in an injector, there is always bother when the plant is closed down. The upward nozzle fills with slime, forming a plug, which even high-pressure air will not always expel. Then the messy and disagreeable task of opening the bottom of the lift is before the mill men. The value of low pressure air as a jet is probably negligible. The simple valve formed by a piece of rubber tube at the end of the air-pipe is as effective as any of the more complicated jets, etc.

In the design given, Fig. 4, every requirement of actual operation is met fairly well. It need only be stated that, when closing down the mill temporarily, a good deal of trouble can be avoided by shutting off the flow of pulp to the lift, and turning on a flow of water or solution. The slime, at least, is washed out and the lift can be easily started again.

The practical mill man opens up the lift before sending a flow of pulp to it, using the water or solution instead, to insure the fact that there is no stoppage. Then the stamps can be dropped with assurance that the pulp will be taken care of.

The following table shows the requirements of various volumes of pulp. Those marked with an asterisk are details from actual cases. The capacities of the various lifts are approximations for submergencies of 45 to 60 per cent. Under practical conditions, the submergence is constantly fluctuating. If the submergence is increased (owing possibly to an increased rate in the feed of pulp) the capacity of the lift is increased, and the air consumption will be diminished, and vice versa when the submergence is decreased.

AIR LIFT DATA.

Rising main.	Well pipe.	Air pipe.	Pulp cap. Cu. ft. per min.	Free air required. Cu. ft. per min.
Ins. diam.				
*1	2½	⅜	1.25	4
1½	3	⅜	3.50	11
*2	4	½	6.60	20
2½	4	⅝	10.00	30
*3	5	¾	15.00	50

Test—A 3-in. air lift, submersion 50%, Pulp 28% solids, gave delivery of 1200 lbs. pulp (15.5 cu. ft.) and consumed 48 cu. ft air per minute.

AIR-LIFTS DRAWBACKS.

Air-lifts have their drawbacks. First there is the submergence to be provided for. In a flat mill site, this is a serious matter. In a terraced mill, part or the whole of the submergence can be obtained at the edges of the benches. Also they do not accommodate themselves to very wide ranges of capacity. For example, if in a 20-stamp mill one lift is provided for all stamps, when 3 of the batteries are hung up, the lift will probably not work well on the small amount of pulp delivered by 5 stamps only. The remedy of having 2 lifts in this case, is obvious.

A well-designed lift intelligently operated, is safe, simple and economical. But mill men must understand that an air-lift cannot be made by putting together 3 pipes one inside the other. The conditions mentioned must be fulfilled. When they are, an air-lift is by long odds the best pulp elevator we have; when they are not, it is an abomination.—*Mining and Engineering World.*

PHENOMENAL SAVINGS IN DRILL SHARPENING

The following is from a special Cornwall correspondent of *The Mining News*, London. He speaks of the necessity of reducing the cost of output in the tin mines, especially in view of a possible reduction in the selling price of the metal. He says:

In only three ways can such a contingency be met—*i. e.*, either by larger output to mill, increased recovery from orestuff, or reduced working costs. At present I propose to deal only with the last mentioned and, while recognizing that increased output means automatically reduced working costs, still there are certain costs which *per se*, whether output be small or large, are susceptible of reduction. To mention only one of these items, take blacksmiths' costs, which at most mines are far in excess of what they should be.

HAND SHARPENING BEHIND THE TIMES.

In underground work hand drilling has largely given way to the air-driven rock drill, not only because it reduces actual costs, but because it gives far higher efficiency, and yet we go on making and sharpening bits by hand at a high cost and for a low efficiency as though nobody had ever heard of a mechanical drill-sharpener, air driven, which makes a perfect bit in one minute and renders the mine independent of that aristocrat, the smith, who knows how to temper and sharpen a bit and takes very good care that everybody else recognizes his superior abilities. The "Leyner" drill sharpener and "Leyner" oil furnace together form an equipment which should be on every mine running over three drills. Neither machine requires foundations, both are compact, occupy little space, and are easily moved, the sharpener being about half the weight of others on the market, whilst in the matter of rigidity and strength it has no superior. Best of all, the machine is, practically, fool proof and requires no highly-skilled blacksmith to work it. Not only does it make a perfect bit in one minute, but it sharpens as no smith can sharpen, and that from the plain chisel bit to the complex two, or difficult five-point star. Further, it shanks any form of steel used for piston or hammer type drills and may be used for heading bolts, pins, and spikes, and forming a great variety of special tools.

ACTUAL SAVINGS BY MACHINE SHARPENING.

As an instance of the economy effected by the use of the "Leyner" I will quote the experience of a European mine where one of the old type machines was installed. Formerly the mine kept a stock of 1,000 steels for use with their drills; now they only need about 600 By the old hand method the waste of steel was, roughly, 22 lb. per day. With the "Leyner" this waste was avoided, the steel being reforged and a saving of 6s. 8d. ($1.66) per day effected, three men were dispensed with and a saving of 7s. 6d. ($1.88) per day effected; charcoal cost is 1s. 8d. ($0.42) per day less, thus bringing the total saving up to 16s. 8d. ($4.16) per day, and that with an old-type machine and in a country where wages are considerably lower than in Cornwall Three hundred days' working of that machine paid its cost and gave higher efficiency in rock-drilling. What would a new type machine effect on a Cornish mine and why is one not seen in action on every mine where rock drills are used? Possibly there is no need to economize in our mines, or it may be that the "Leyner," not being of local manufacture, has failed to secure the glad eye so generally reserved for native merit.

ELECTRIC SWITCHES IN GASEOUS MINES

The flash resulting from the opening of a 250-volt direct-current circuit carrying more than half an ampere will ignite explosive mixtures of mine gas and air. An equally dangerous flash may be produced by even less current from a 500-volt circuit. Few mine electric circuits carry less than half an ampere when in use. The need of protecting the switches of such circuits in places where gas is likely to be present is therefore obvious.

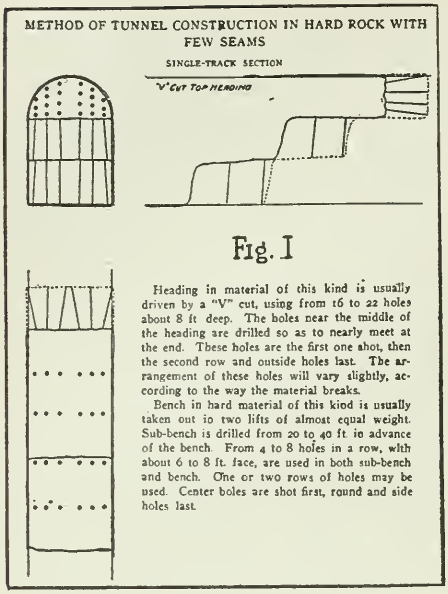
Two general methods have been proposed for preventing switching flashes from igniting gas surrounding the switch. One method is to inclose the switch in a casing provided with openings that are covered with wire gauze or otherwise designed and equipped for preventing the passage of flames from the interior to the exterior of the switch casing. Switches so protected are called explosion-proof switches. The second method is to immerse the switch contacts in oil to a depth sufficient to quench any flash that may occur when the switch is operated. Switches so protected are called oil switches.

The success of the first method of protection depends upon the proper design and construction of the switch casing. It is essential to the successful operation of the second method that the switch contacts be surrounded by the proper kind of oil in good condition. There are several ways in which an oil switch may be deprived of its protective feature. The oil tank may not be filled, or, if filled, the oil may leak out or be spilled. The oil tank may be removed (in some designs) and not replaced, or through neglect the condition of the oil may become such that it is no longer an efficient protection. While such contingencies are not likely to occur, and although oil switches may be so designed that the loss of oil is not probable, nevertheless, as compared with oil switches, explosion-proof switches seem to possess a greater element of safety because their protective features are inherent in their construction, and for that reason are not likely, when needed, to be missing or impaired if the mechanical construction of the switches is sufficiently durable. Moreover, switches of the explosion-proof type can be so designed that the condition of their protective features may be readily observed each time that the switches are operated.

The above are the opening paragraphs of Bulletin 68, just issued by the Bureau of Mines of the Department of Agriculture which may be had free by any one who will write for it. It describes a series of carefully conducted tests of electric switches and is liberally illustrated.

A NEW JOB FOR PNEUMATIC HAMMERS

In the process of annealing in steel sheet mills the sheets go into the ovens in large bundles, and when they are taken out they are stuck together so that it is difficult to separate them. By striking the bundles with iron or soft hammers it is possible to break up the mass into packages, say three-quarter inch thick, from which the individual sheets must be separated by hand, using crescent shaped spreaders. A series of tests with specially designed pneumatic hammers has produced gratifying results and showed that it would be advisable to pipe the floor with compressed air even for this service alone.


METHOD OF TUNNEL CONSTRUCTION IN HARD ROCK WITH FEW SEAMS

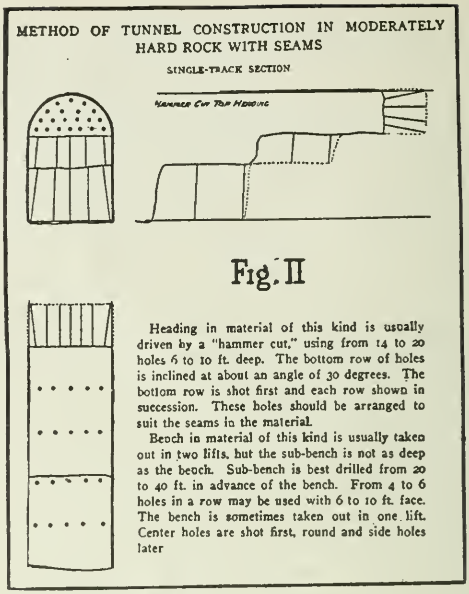
SINGLE-TRACK SECTION

Fig. I

Heading in material of this kind is usually driven by a "V" cut, using from 16 to 22 holes about 8 ft deep. The holes near the middle of the heading are drilled so as to nearly meet at the end. These holes are the first one shot, then the second row and outside holes last. The arrangement of these holes will vary slightly, according to the way the material breaks.

Bench in hard material of this kind is usually taken out in two lifts of almost equal weight. Sub-bench is drilled from 20 to 40 ft. in advance of the bench. From 4 to 8 holes in a row, with about 6 to 8 ft. face, are used in both sub-bench and bench. One or two rows of holes may be used. Center holes are shot first, round and side holes last.

V CUT HEADING.


METHOD OF TUNNEL CONSTRUCTION IN MODERATELY HARD ROCK WITH SEAMS

SINGLE-TRACK SECTION

Fig. II

Heading in material of this kind is usually driven by a "hammer cut," using from 14 to 20 holes 6 to 10 ft. deep. The bottom row of holes is inclined at about an angle of 30 degrees. The bottom row is shot first and each row shown in succession. These holes should be arranged to suit the seams in the material.

Bench in material of this kind is usually taken out in two lifts, but the sub-bench is not as deep as the bench. Sub-bench is best drilled from 20 to 40 ft. in advance of the bench. From 4 to 6 holes in a row may be used with 6 to 10 ft. face. The bench is sometimes taken out in one lift. Center holes are shot first, round and side holes later

HAMMER CUT HEADING.

ECONOMY IN TUNNEL DRIVING

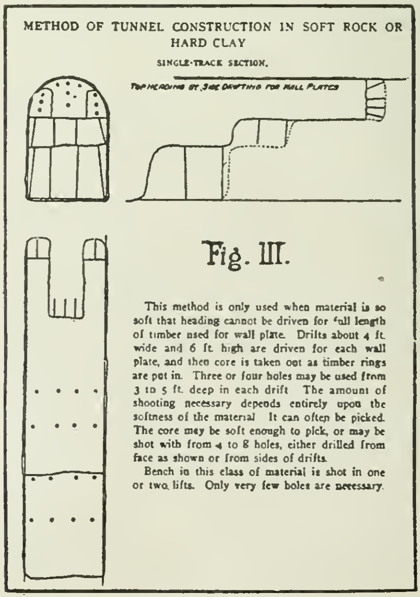
In the report of the committee on roadway at the Chicago convention of the American Railway Engineering Association, it was said that railway tunnels, as ordinarily constructed in the United States, are more economically built by first driving the heading entirely through, although this method generally requires a greater length of time for the completion of the job. They say further:

That it is economical and expedient to use an electric shovel or an air shovel for the removal of the bench where the section of the tunnel permits the safe operation of the same; and that where the material does not require support, there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.

That where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept 50 feet in advance of the bench. Where the material of roof is not self-supporting and timbering is to be resorted to, the bench should not be removed until the wall plates are laid and the arch ribs or centering safely put up.

That opposing grades should not meet between the portals of a tunnel, so as to put a summit in the tunnel, and where practicable, the alinement and ascending grades in the tunnel should be in the same direction as the prevailing winds.

The three cuts herewith are representative of American practice in single-tracked tunnel construction where the time limit is insistent; Fig. 1 showing the V-cut heading; Fig. 2, the hammer-cut heading and Fig. 3 a top heading by side drifting for wall plates.


METHOD OF TUNNEL CONSTRUCTION IN SOFT ROCK OR HARD CLAY

SINGLE-TRACK SECTION.

Fig. III.

This method is only used when material is so soft that heading cannot be driven for full length of timber used for wall plate. Drifts about 4 ft. wide and 6 ft. high are driven for each wall plate, and then core is taken out as timber rings are put in. Three or four holes may be used from 3 to 5 ft. deep in each drift The amount of shooting necessary depends entirely upon the softness of the material It can often be picked. The core may be soft enough to pick, or may be shot with from 4 to 8 holes, either drilled from face as shown or from sides of drifts.

Bench in this class of material is shot in one or two lifts. Only very few holes are necessary.

SIDE DRIFTING.

A MUNICIPAL AIR LIFT PLANT

The water supply of any city is never without its features of interest from an engineering view point, and each city differs from every other in some particulars, while the range of divergence both as to the sources of supply and the means by which the supplies are made reliably available is practically unlimited. Those cities are most fortunate which have pure water within reach even if special arrangements are necessary for securing, storing and distributing it. The city of Savannah, Georgia, has had its share of experience with its water supply and is now in a position to congratulate itself upon the outcome.

Until about 35 years ago all the water for the city service was pumped from the Savannah river, the supply only limited by the pumping capacity, but the quality no better than that of other full grown rivers. Then 15 flowing wells were bored about two miles out of the city, the water being then pumped into the city mains under the required head. This was called the "River" plant. In 1892 another plant was established with 13 wells about a mile and a half away, known as the "Gwinnett Street" plant.

As other wells were constantly being drilled in and around the city the wells which originally flowed a half million gallons in the 24 hours from each well finally stopped with the water 12 ft. below the surface. The suction from the pumping engines was connected to the wells with results far from satisfactory or reliable. In 1902 a steam driven Corliss compressor was bought from the Rand Drill Company, size 18 and 28x20x36 for operating air lifts. This compressor was run with a surface condenser and showed good power economy. The next year a duplicate of this machine was bought, these both being placed in the Gwinnett Street plant. In 1913 the underwriters conducted a test, and on a one hour's run they pumped at the rate of 18,000,000 gallons in 24 hours.

AIR LIFT DISCHARGE BASIN.

The River plant was operated in connection with the Gwinnett Street plant by using a compound steam pump until 1908, when an Ingersoll-Rand Imperial Corliss condensing compressor was installed, 14 and 24 and 20x20x20 in., and this machine has since been used as a booster to the Gwinnett Street plant. One machine is run for a month at Gwinnett Street and then the other is run for a month, while the River plant machine runs from two to six hours a day as required. The wells at Gwinnett Street are all 12 in. diameter and are not reduced; those at River Station are some 4 in. and some 6 in., and the working air pressure is about 50 lb., gage.

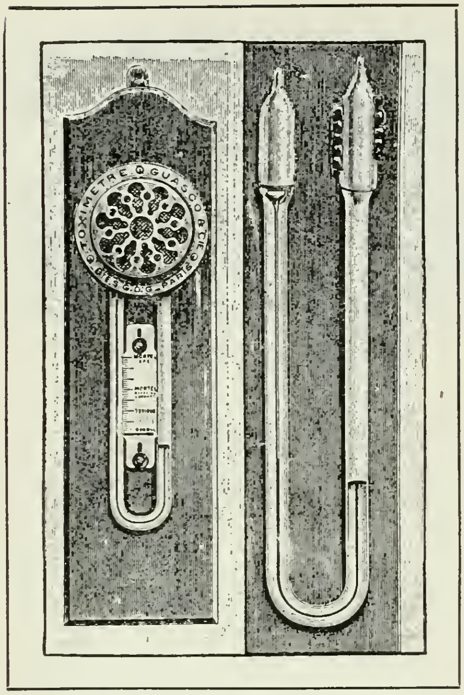
The total cost of pumping at Gwinnett Street, including the pumping into the mains, based on actual cost including operation and repairs but not depreciation or interest, is at the rate of $9.90 per 1,000,000 gallons. Here they use crank and fly wheel Corliss pumping engines; at River plant, using pumps not as economical and operating only intermittently, the pumping costs are higher.

At River plant they were pumping at the rate of 1,000,000 gallons per day; after putting in the compressor they reached a rate of 8,000,000, but ordinarily the rate is maintained at 5,000,000. The half tone, which does not tell us much, was taken at the River plant

---

A MOTOR TRUCK RETARDER

The manufacturers of a French motor truck have added to it an air brake of novel principle. It might more properly be called a retarder or controller, its most essential element being a fan, like that used in the mechanism of striking clocks. When the motor truck is on a long down grade, on which continued application of hand or emergency brakes would burn the brake lining, the driver pulls the "air-brake" lever. The revolving shaft acts by means of a bevel gear upon a wide-bladed large fan mounted horizontally below the body of the truck. The resistance of the atmosphere to the forward motion of the fan blades retards the shaft revolutions sufficiently to brake the truck.



SENSITIVE GAGE FOR MINE GASES.

GAGE FOR POISONOUS GASES IN THE AIR

A gage which will show the presence of poisonous gas in the atmosphere in a proportion as low as 1 to 10,000 has been invented by a Frenchman named Guasco, who has named it the "toximeter," a designation far from original.

It is described in *La Nature* by G. Chalmares, who notes that it is intended particularly to give warning of the presence of carbon monoxid—the gas that burns with a blue flame in a freshly made fire of anthracite. The greatest care, Mr. Chalmares remarks, must be taken, in the installation of a heating or lighting plant, to avoid the production of this substance. He writes:

Other gases, such as carbureted hydrogen and acetylene, happily betray their presence by their odor long before a fatal dose is reached. It is not so with carbon monoxid, which has no odor and is very poisonous, even in very slight quantities. For this reason many attempts have been made to discover means to make its presence konown in air intended for respiration, before fatal consequences have been reached. Chemical reactions have generally been employed—a delicate process, sometimes too sensitive, necessitating manipulations which, although simple enough, can not always be performed.

Mr. Guasco has conceived the idea of utilizing the property possessed by platinum sponge of becoming rapidly heated in the presence of carbon monoxid, which it absorbs in large quantities. This property has been practically utilized for several years for lighting gas-jets and for a long time past in the hydrogen briquet. He has thus invented a device necessitating no manipulation. It is formed of a Leslie's differential thermometer, which, as is well known, is a U tube ending in two bulbs full of air; a mercury column or a section of colored liquid is displaced in the tube at the slightest difference of temperature between the two bulbs. Mr. Guasco fastens to one of the bulbs ten pastilles of platinum sponge; the corresponding side of the tube is covered and the other branch is graduated. When the apparatus is in a medium containing corbon monoxid, there is a difference of temperature, revealed almost instantly by a movement of the column, which is greater and more rapid the more of the poisonous gas there is in the atmosphere. Evidently other gases, illuminating gas, for instance, will have the same action, but they will also betray themselves by their odor. It is thus for carbon monoxid that the indications of the toximeter will be valuable. The (French) Inspector-General of Mines has presented the device to the Academy of Sciences, after having experimented successfully.

On his part, Mr. Guasco has made numerous experiments from which he finds that the movement of the gage in the U tube is about half an inch for the proportion of 1-1,000 of carbon monoxid, which makes it possible to use graduations that will show 1-10,000 of the toxic gas.

In a special model, the inventor has used mercury for the indicating column and has placed a platinum contact-point in the tube. This closes an electric circuit and operates either a bell or an incandescent lamp, thus giving notice, even at a distance, by sonorous or luminous signal, that there is danger from the abnormal presence of poisonous gas.

Compressor, chipping hammer, sand rammer, molding machine, sandblast, sand riddle and air hoist, have become parts of every well organized foundry.

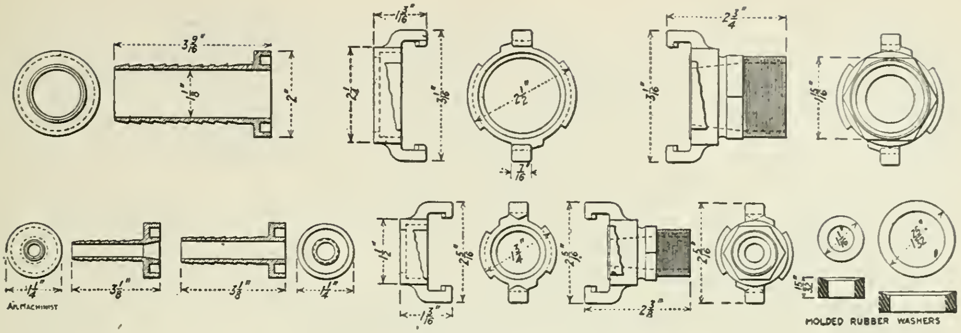


Fig. 1. Quick-Acting Hose Fitting

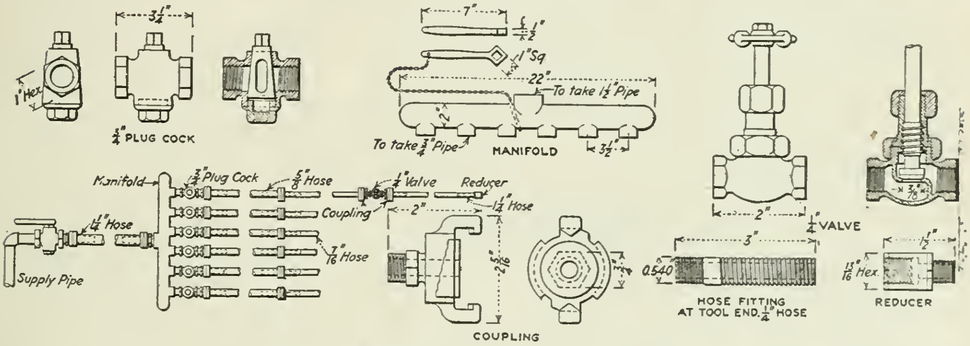


Fig. 2. Methods of Connecting Up Air Hose

COMPRESSED AIR HOSE FITTINGS

BY G. A. BISSEL.*

The Hull division of the Portsmouth Navy is now entirely equipped, with the universal quick-acting hose fittings and manifold fittings, as illustrated in Fig. 1, which have been invented and developed by me. There are nearly 3000 of these now in use. The couplings differ from other universal couplings in that as the rubber washers become old or worn, the coupling can be set up another notch, the cam on which the lugs bear having five locking points.

An ideal layout for a shipyard or navy yard is shown in Fig. 2, the 1¼-, 1⅝- and 1$^{7}/_{16}$ in. hose being the three standard sizes now used in all navy yards. Fig. 2 also shows, on one section of hose, a valve located close to the hammer. This arrangement is frequently used when the air manifold is located on deck while the workman is below decks. Instead of having to go up on deck to shut off the air at the manifold, he can shut it off at the nearby valve.

It is found that the new couplings have admirably fulfilled the purposes for which they were designed, namely, first to avoid leakage of air; second to economize the time of the workman; third to require little care.

The rubber washers on the old couplings were constantly being blown out and lost. This difficulty is obviated in the new coupling.

The manifolds shown in Fig. 2 are provided with cocks for operation with a handle. Only one handle is provided for each manifold. It was found that when handles were provided for each cock they were in the way and frequently became bent so as to interfere with their operation. The type of cock shown is that found most satisfactory. The nut at the bottom serves to increase the pressure on the springs. when necessary, to prevent the cock from leaking. It is not on the spindle of the cock, consequently there is no tendency to unscrew it when turning the spindle. The usual type of cock has a nut on the spindle—this is objectionable as it makes it leaky after a short period of service.—*American Machinist.*

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*Naval Constructor, U. S. N., Portsmouth N. H.

WHISTLE SIGNALS*

1. Steam-shovel engineers must be conversant with all warning signals, and it is made the responsibility and duty of each engineer to give warning of all blasting in the vicinity of his steam-shovel.

2. Sound of the whistle must be distinct, with intensity and duration proportionate to the distance signal is to be conveyed.

3. Each shovel must be equipped with a distinctive toned steam whistle. All shovels are numbered plainly, with a number in full view from all parts of the workings. Employees must familiarize themselves with the distinguishing sound of the different shovel whistles in order that they may readily locate blasting operations and be prepared to safeguard themselves from possible danger of flying rock and debris.

4. Powdermen and blasters must not "spit" or light a fuse or fire a charge until after the alarm and warning signal has been sounded by the shovel engineer.

5. Signal for blasting shall be a series or succession of short, sharp, quick blasts of whistles, continued for brief period, to be followed immediately by as many long sounds of whistle as there are shots to be fired. To illustrate: if there are 10 shots to be fired, the nearest shovel will sound the alarm series of short, quick "toots" of the whistle, followed after a brief interval by 10 long sounds, indicating 10 rounds or shots to be exploded.

6. The signal prescribed and herewith set out are illustrated by the word "short" for short sounds, and the word "long" for long sounds or blasts of the whistle:

SOUND.	INDICATION OF WARNING.
1 long, 1 short	Beginning and end of shift.
2 short	Move up shovel.
3 short	Calls waterman, pipemen, and lighters.
4 short	Calls powderman.
5 short	Calls foreman.
Series short, quick	Warning signal—blasting.
Followed by number of long	Indicates number of shots to be fired.
2 long	Round or charge of blasting completed.

The signal for "seam" shots, distinguished from bore-hole shots, top blasting, or bulldozing, will be the regular alarm signal followed by whistle sound of longer duration than the long signal indicating number of shots to be fired. While a seam shot may not be more dangerous than other blasting, the shattering effect of such a shot may cause the throwing of small pieces or particles of rock a greater distance than a top blast would. Employees are, therefore, urged to heed this signal and to seek shelter with all possible dispatch.

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*From the book of "Rules and Regulations" of the Nevada Consolidated Copper Company

DIFFERENT SAND BLAST NOZZLES

BY B. H. REDDY.

Cleaning castings with sand blast apparatus can be made to show considerable economy over the ordinary method of chipping, scraping and brushing by hand, and at the same time the operation leaves the castings in such a condition that the expense of machining is reduced materially. All burned sand and scale are thoroughly removed from the surface of the castings, thus greatly lessening the wear on the edges of the cutting tools. But it is remarked frequently that although the sand blast does nice work, it is expensive. This, however, depends entirely on the manner in which the sand blasting is done. If a greater air pressure is used than is necessary to perform the work, a loss results from the excessive power required to compress the air, and there also is an unnecessary amount of sand lost through breakage of particles. Improperly designed nozzles frequently increase the expense of sand-blasting unnecessarily.

Due to the abrasive action of the medium used, the nozzle tips wear out rapidly. In an effort to overcome this, many different materials and forms of construction have been tried. Tips have been made from rubber, tempered steel and chilled iron. Nevertheless, the abrasive action of the sand cannot be avoided and although the wear has been minimized in some cases, it still exists. The rate of wear varies greatly with the type of nozzle employed.

Fig. 1 shows a section of a nozzle commonly known as the suction or injector type. The tips *A* and *B* are made of chilled iron. The air, under pressure, escapes from tip *B* through tip *A* and forms a partial vacuum in the sand hose. This sucks air and sand through the hose. The inside of tip *A* wears out rapidly while the outside of tip *B* also is cut away somewhat more slowly. When using this form of nozzle it is necessary to arrange the feed at the entrance of the sand hose in such a manner that it will not become clogged.

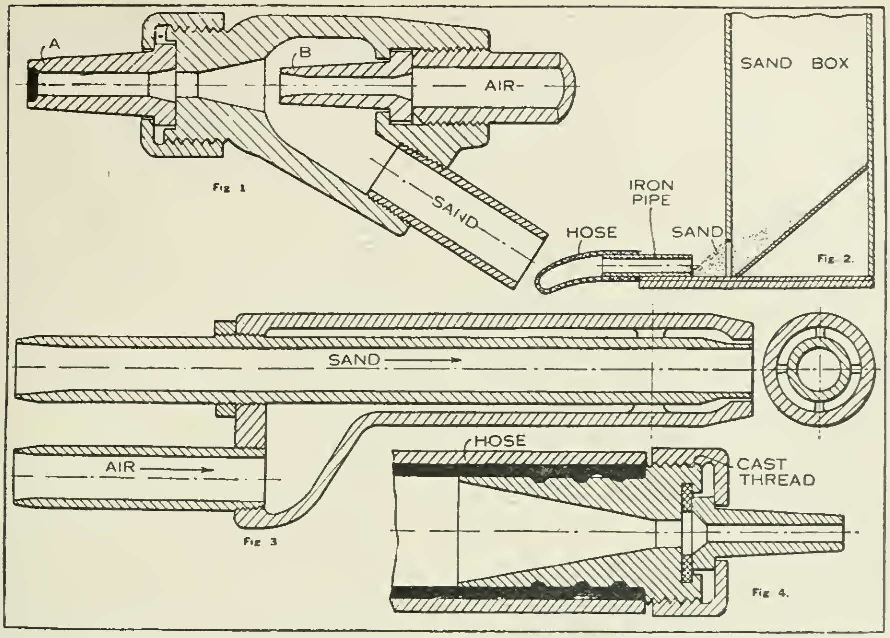

FIG. 1—INJECTOR TYPE SAND BLAST NOZZLE

FIG. 2—ARRANGEMENT OF SAND BOX AND SUCTION HOSE ENTRANCE

FIG. 3—LONG WEARING TYPE SUCTION NOZZLE

FIG. 4—CAST IRON NOZZLE FOR PRESSURE MACHINES

Fig. 2 shows a simple method by which this can be accomplished. The sand is kept in a box which is provided with a sloping floor leading to a chute through which the sand flows onto a platform. The end of the hose is fastened to the platform in such a manner that the sand is readily sucked in. The nozzle, however, is wasteful of both sand and air. By cutting off the sand supply, the nozzle may be used for removing loose sand, blacking, dust, etc., from otherwise inaccessible places in molds.

Fig. 3 illustrates a form of nozzle designed to reduce the wear at the tip. The air escapes from a narrow annular opening surrounding the end of the sand tube, and only a portion of it does useful work in carrying particles of sand. Energy is imparted to the sand only at great loss of efficiency, but the wear is reduced to such an extent that one nozzle may be used for a number of months. A nozzle of this type usually is employed in such a manner that the work lies underneath it or else it is suspended by the sand hose from an elevated bin so that the sand feeds by gravity. As there is very little suction through the sand hose, the nozzle cannot be directed upward at more than a slight angle. It is also said that it will not work in deep pockets. Nozzles of this type usually are made in such sizes that they use from 250 to 300 cubic feet of air per minute.

Fig. 4 illustrates an economical nozzle which uses about 75 feet of air per minute. In this nozzle no energy is expended in bringing up the sand; neither can any of the air escape without imparting its energy to the sand. But, on the other hand, the nozzle can be used only with a pressure type machine in which the sand is contained in a closed tank. The tip is subjected to wear, but is so designed that it may be replaced readily and the cost of maintaining the nozzle is low. The various parts can be made from castings and assembled without machine work. The tips usually are made of white iron. As the tips increase in inside diameter, the consumption of air increases. The outside of the tips may be tapered in such a manner that when the inside has been cut out to a predetermined size it will show on the outside. Any workman can readily interpret this phenomenon as a signal to change nozzles.

Complaints frequently are heard regarding the wearing qualities of sand hose, but this is often due to the fact that proper materials are not used in manufacturing the hose. It should be borne in mind that the quality and not the thickness of the inner lining of the hose determines its resistance to wear. A lining which will stretch out almost like a good rubber band when a small piece of it is pulled out between the forefinger and thumb nail, is one which will give good service.—*The Foundry.*

CAVE AND TUNNEL FARMING

The following should appeal to our readers because we are all interested more or less in tunnels, and there are many unused tunnels which might be put to the use here suggested.

A cave in the heart of the Ozark Mountains of Missouri is the unusual spot chosen for a farm by a retired citizen of St. Louis. While looking about for a farm in the western part of his home State, Mr. Robert Smith found an attractive 26-acre stretch, beneath part of which lay a large cave. Remembering the profitable use made of caves by the mushroom growers of southern France, he determined to test the productiveness of his acquisition.

While his neighbors were digging up weeds and clearing brushwood from their lands, Farmer Smith had to uproot and haul away the stalagmites and stalactites, the lime deposits left by the incessant dripping of water during many centuries. Except for a clayey substance, ocher, which covered part of the walls, the cavern floor was bare limestone, so that the final preliminary activity was to spread soil and manure over the ground.

Mushrooms are peculiarly suitable for such a project as the cave farm. The spawn is secured in bricks, which are broken up and scattered over the floor surface. From a single mulching, and with almost no care, the farmer can harvest a new crop of marketable mushrooms every day for three months. Allowing a brief period for the fungus to attain its full size, Mr. Smith can readily plant spawn three times each year. From this promising start, the subterranean agriculturist turned naturally to rhubarb and celery. These are planted above ground, and are later transplanted in the cave. The underground ripening causes an unusually rapid growth, the rhubarb gaining on the average an inch a day in length, and also gives the stalks a superior tenderness and a rich flavor.

COMPRESSED AIR FOR STERILIZING MILK

A new process for the sterilization of milk, called the "Biorisator," is said to be in successful use in some German dairies. The milk is poured into a pressure chamber, where it is subjected by a pump to a pressure of 4 atmospheres; it is then conveyed by the same pressure to a large cylindrical vessel, which it enters in the form of a fine spray, and is, at the same time, subjected to a temperature of 167 deg. Fahr. From the cylinder it passes through a cooler, where its temperature is rapidly lowered to at least 50 degrees. From this it flows to a bottle-filling machine. The milk is subjected for only a brief time to the sterilizing temperature while in the form of a spray. The advantage claimed for the biorisator process, as a substitute for the ordinary methods of pasteurization and sterilization, is that while it insures the destruction of pathogenic germs, it produces no change whatever in the chemical composition of the milk. The latter retains all the properties of raw milk, and can be used for cheese making, besides keeping much longer than either raw or pasteurized milk.

VARYING AIR PRESSURE TO SUIT THE TIDES

Recent underground railway work in London has required the construction of a considerable length of tube under the Thames. In this part of the work, driven by the usual shield plan, the clay cover in the river bed is very thin while the tide causes considerable variation in the depth of the water over it, and on account of this it has been necessary to vary the air pressure daily during construction from 9 to 18 lb. per square inch. Had this precaution not been taken there might have been an excess of pressure at low tide, which would have lifted the river bed, whereas at high water, with too little pressure, there would be the danger of the river breaking in. The method adopted to insure that the right air pressure was maintained in the tunnel was to have a gage fixed in the river with marks corresponding to the air pressure which should be employed, and to regulate the pressure from observations of the gage readings.

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SAFETY FIRST WITH COMPRESSED AIR

Safety First, the industrial guidon of the hour, should nevermore be allowed any position but at the front of our activities, and especially should it be kept prominently in sight in compressed air practice, although nothing can well be imagined safer than air is in itself; and we should not forget that one of its chief employments is, as in the air brake and in the switch and signal service, for eliminating, or at least for minimizing, the dangers which seem inseparable from our schemes for rapid transportation.

What air has done for safety in this field alone is incomputable. It is a curious thing that while casualties are self recording, while complete lists of accidents which have occurred are generally accessible, there are no records and no possibility of recording the accidents which might have occurred, which surely would have occurred, only that they have been prevented by the operation of safety devices, and especially by those pneumatically operated, so that compressed air does not receive the honors it earns.

And yet compressed air has its conditions—if it is permitted to it to have them—which are not all in the line of perfect safety; but the arrangements to be adopted for avoiding the possible dangers are all in the direction of practical economy as well, so that, independently of the value of the safety secured, it is cheaper to produce compressed air—the compressed air produced is cheaper—which is also produced under safe conditions.

One of the first conditions essential to safety in the use of compressed air is that the air after compression shall be as pure as possible. This applies especially to caisson work where all the air breathed by the workers is what comes from the compressor, and if this air is charged with vapor or smoke from highly heated or burnt oil it is very different for respiration from air which is not so vitiated.

The danger to which the sand hog is exposed in his work has too generally been thought of as that due to the pressure alone, but the purity of the air in which he works has also much to do with it, and it would seem to be high time that this was more generally recognized. Of course the less oil there is used in air cylinder lubrication the less of the oily constituents there will be in the air as it is delivered to the work. This applies as well to tunnel headings or wherever the air which has been compressed is afterwards breathed by the men. We have published in these pages accounts of the minute quantities of lubricating oil used in the compressors on the Panama Canal, and still less elsewhere. The reduction in the quantity of oil used, and in the cost of it, may not be a very large item in the total running expenses, but it is still in the direction of economy of operation.

The matter of keeping the air as cool as possible during the compression and delivering it as cool as possible and as dry as possible after the compression is still more important as a means of safety, and of comfort, and it also is an essential condition of economical operation. We know that two stage compression, at least for all pressures above 50 lb., is necessary if the temperature is to be kept down, and we know also that power is saved by this arrangement. The intercooler, the aftercooler and the separator cost nothing except for their installation, while the resulting economy and collateral benefits are indisputable.

By the way, the matter of moisture in the air is treated in easily readable style in another article in our present issue.

LOW PRESSURE ILLUMINATING GAS

"In Syracuse, N. Y., a city with 170 miles of gas mains of from 2 to 20 in. diameter, the pressures varies from 1½ to 3½ in. of water, or, say $^1/_{20}$ to ⅛ lb. per sq. in."

Some reader of Frank Richards' new book, *Compressed Air Practice*, has started the above interesting item on its rounds; we clip it from the *American Machinist*. The fact is that Syracuse was merely cited as typical of all the cities in the country, where distributing pressures adopted more than a century ago are still submitted to. If customers need higher pressures to enable them to use the gas more economically and satisfactorily they must make arrangements of their own for increasing the pressure, and not disturb the gas holders or the costly but incompetent pipe lines.

The recorded sales of gas for the boroughs of Manhattan and the Bronx, New York City, for the year 1913 were 26,262,457,670 cubic feet, an increase of only 0.39 per cent. over 1912.

AN IMPORTANT COMPRESSOR CONTRACT

The Isthmian Canal Commission has just awarded to the Ingersoll-Rand Co., the contract to furnish three large Direct Connected, Electrically Driven Air Compressors of the Duplex Type, embodying the new Ingersoll-Rogler valve. The combined capacity of these units will be 10,000 cu. ft. free air per min. They will be installed at the Balboa shops, where the air will be used for general repair work in the shops and also on the new dry dock. This equipment is to form a part of the permanent canal equipment.

HIGH PRESSURE GAS AT THE SAN FRANCISCO EXPOSITION

It seems to be coming more and more to be understood that when gas is to do its best it must be used at pressures much higher than these vouchsafed to ordinary, every day consumers. The following abstract from *The Gas Record* is suggestive in this direction.

"At the Panama-Pacific International exposition it is believed that some of the most spectacular lighting effects will be gained where the gas system is employed. This will be particularly noticeable in the Court of Abundance designed by Louis C. Mullgardt. The court will be illuminated almost entirely by gas under high pressure. Urns will be placed about the court and on the border of a still lagoon in the center, from which twisted gas flames ten to fifteen feet in height will rise.

"Steam jets constantly will be pouring a cloudy vapor over the entire court and casting a haze over the reddish-yellow flames. By an ingenious scheme free gas will be forced through the water in the lagoon and ignited upon reaching the surface. These giant bubbles of inflammable gas will burst at intervals of a few seconds. The effect of these seemingly mysteriously derived flames augmented by steam under pressure may be readily imagined.

"The essential secondary system of lighting for the exposition will be by means of gas arcs installed in all of the exhibit palaces and in entrances and about the grounds. The street lighting in the states and foreign sections and in the concessions district will be exclusively by means of gas.

"It will be distributed through a high-pressure system by a San Francisco company and will be the oil gas which is used in California and is made from crude petroleum. Its heat value is 600 B. t. u. per cubic foot and even more and it has a candle power in excess of 18. The pressure on the grounds will be thirty pounds.

"While the gas will be distributed at thirty pounds pressure it may be reduced to any amount suited to the use to which it will be put by means of regulators which will be installed upon request, by the company supplying the gas."

The big gas holder will of course be conspicuous; but it will be conspicuous by its absence.

SPRAYING MOLTEN METALS

In Compressed Air Magazine, September, 1911, a description was given of the Schroop metal coating process. By this process articles composed of almost any solid material, and even textiles, are coated by directing upon them a fine spray of molten metal which solidifies as it is deposited. An improved apparatus in the same line has recently come into use and is described in the *Revue de Metallurgic,* Paris, Dec., 1913.

The machine is called a pistol syringe. The metal in the form of wire is fed automatically into it, and melted by means of an oxy-hydrogen flame, or a flame where the hydrogen is replaced with illuminating gas. The molten metal is sprayed with compressed air which also works a small turbine that advances the wire. The use of metallic powder is therefore obviated. The details of the construction are given, and several views of it in use. The most diverse metals can be used—lead, tin, zinc, aluminum, copper, brass, etc. The inventor also anticipates a successful use of glass and enamel. Very thin coatings can be produced for purely decorative purposes, or thicker ones that can be polished by ordinary methods, and if desired removable coatings several millimeters thick for reproducing medals, plates for engraving, etc.

THE MOST SERIOUS DANGER IN COAL MINING

Falls of roof and falls of coal were during the year of 1912 responsible for the loss of a larger number of lives and a larger number of serious permanent injuries than can be attributed to any other two or three causes. The causes of these accidents are much more complex than is usually supposed, and to apply the remedial measures adopted in some other countries would greatly increase the cost of coal to the American consumer. The subject is, therefore, worthy of a careful investigation, which it is estimated, would cost $35,000 to $40,000 a year for several years. This cost is insignificant when it is remembered that from this cause alone during the past five years more than 5,000 lives have been lost and many times that number of other serious accidents have occurred. Taking the average recent compensation rate of $3,000, the labor loss to the country from this one cause has been more than $15,000,000 in five years, and the loss is much greater if the associated permanent nonfatal injuries be considered.

In those districts where the prevailing practice has been to shoot off the solid, the growth of a sentiment in favor of undercutting the coal is noticeable. Shooting off the solid—with the attendant use of large charges of explosive which shatter the coal, increase the proportion of fine dust, and injure the roof—has been responsible for more accidents to miners and more loss of property than almost any other coal-mining practice.—*Annual Report Bureau of Mines.*

PYRENE AS A FIRE EXTINGUISHER

Pyrene is a combination of powerful gases maintained in liquid form without pressure and absolutely devoid of moisture. When pyrene liquid is subjected to a temperature of 200 degrees F. or over, it is immediately transformed into a heavy, dry, cohering, nonpoisonous, gas blanket. When the contents of a pyrene extinguisher are thrown on a fire 3,760 cubic feet of extinguishing gas is generated. The hotter the fire, the greater is the expansion of gas. In its liquid state pyrene contains neither acid nor alkali, and it does not deteriorate with age.

A scenic road is being built from Revelstoke, B. C., up Mount Revelstoke to Victoria Park on its summit. Commencing on the western boundary of the city, at an altitude of 1,450 feet, with the aid of five switchbacks, the road reaches the summit, 12.8 miles distant, at an altitude of 6,150 feet.

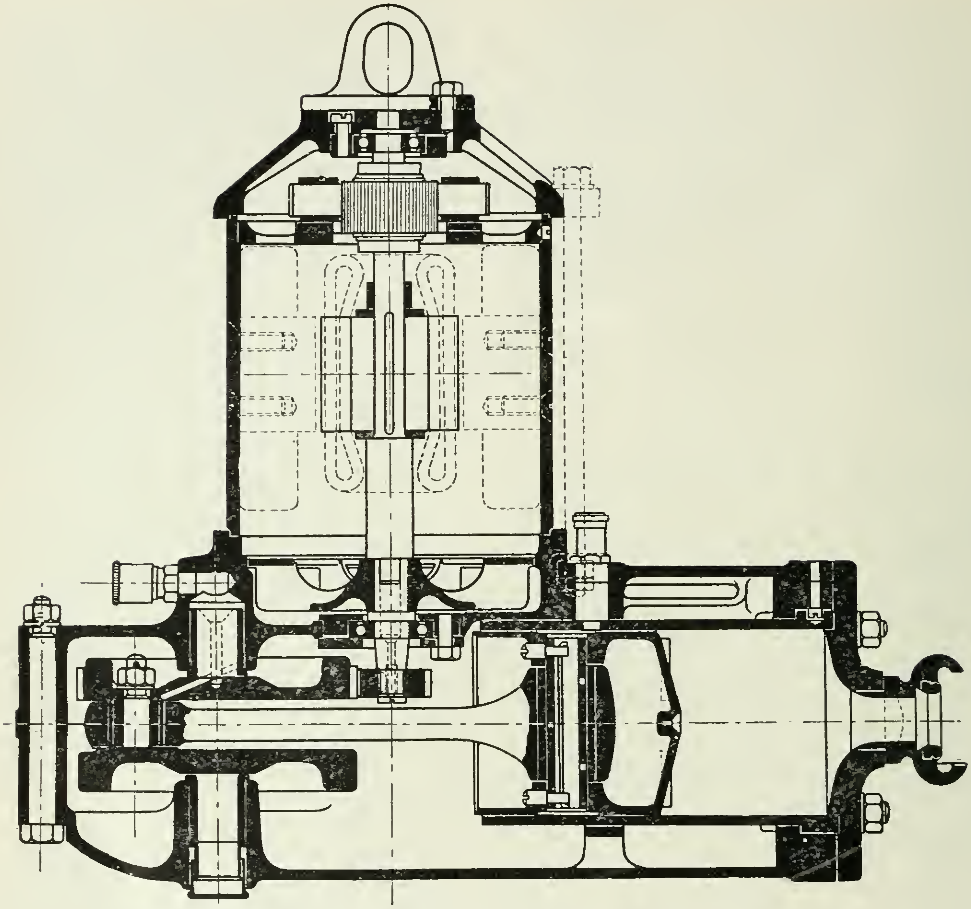


FIG. I

A NEW ELECTRIC PNEUMATIC HAMMER

We reproduce from the *Engineer,* London, a cut, Fig. 1, showing the essential features of a new device for operating a pneumatic hammer, the half tone, Fig. 2, showing the apparatus complete and ready for work. A rather meager description is given of the arrangement and operation, but it explains itself quite clearly. There is an electric motor connected by speed reducing gearing to a shaft the crank of which drives the piston of a single acting air compressor or pulsator. A small air hose connects the pulsator with the hammer to be operated, permitting the latter to be moved about with perfect freedom within the reach of the hose.

The motor, crankshaft and pulsator piston may be assumed to run at approximately constant speed. The compression stroke of the piston drives the air into the hammer and causes it to strike its blow. The return stroke of the piston, at the latter part of it, creates a partial vacuum in the working chamber of the hammer, and this vacuum permits the atmospheric pressure on the other side of the hammer piston to return it to the starting position for the next working stroke, and so on.

It is to be remembered that in the various types of pneumatic hammer in use, and also in the electric air drill, positive air pressure is employed for the return stroke of the piston, and it is not to be believed that the partial vacuum used for the return stroke in the apparatus here illustrated can ever be sufficient for rapid and effective working.

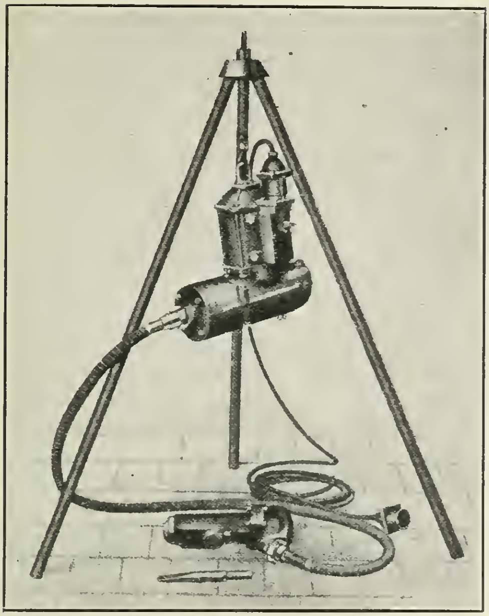


FIG 2.

A STETHOSCOPE TRICK

Down in Williaim street there is a large building devoted mainly to the insurance business. It is in every way a successful building. The biggest leak in overhead charges in this building was in the water bill, says *The Real Estate Record and Guide.*

The owner watched for wastefulness, but could not find it. Finally, one Sunday, he borrowed the stethoscope, of his brother-in-law, who is a physician, and, with the aid of his engineer and superintendent, went over the piping, shutting off the water supply at each cut-out station. After going over all of the open plumbing work that was exposed they passed to the roof tank and there made an important discovery.

One of the plate rivets had unaccountably disappeared and permitted a stream of water about three-quarters of an inch in diameter to escape. This water, raised to a distributing point by an expensive pump battery, discovered an outlet by following one of the steel columns down to the roof, where it found its way between the roof tiles and the ceiling to a point in a side wall, where it forced its way out under a window sill abutting the neighboring building, and thence flowed down fourteen stories to the ground, without revealing its presence through the roof or ceiling at any point.

Without the aid of the stethoscope, which directed the searchers to the hidden leak, the fault would probably not have been discovered until some important part of the steel framing had been weakened by rust or seepage and endangered the foundation.

NOTES

Mr. George A. Gallinger, of Pittsburgh, has been placed in charge of the Pneumatic Tool Department of the Ingersoll-Rand Company with the title of Manager of Pneumatic Tool Sales. His headquarters will be at 11 Broadway, New York City.

In the last three years the excavation incident to the mining of coal in West Virginia alone has been greater than the excavation required in eleven years to dig the Panama Canal.

A 250-mile pipe line is being built for H. M. Byllesby & Co., of Chicago, from the West Virginia gas fields to Louisville, Ky. Some 76 miles of difficult construction through the mountains has already been completed.

Mr. Frank B. Gilbreth, the well known "efficiency engineer" has started a museum at Providence, R. I., for the exhibition of devices for eliminating fatigue. The fatigue of readers of scientific management "literature" should be relieved in some way. Everybody in these days seems to need a rest.

The composition of natural gas as used at Pittsburgh is: 83.1 per cent. methane or marsh gas, 16.0 per cent. ethane, 0.9 per cent. nitrogen, with a trace of carbon dioxide. The most explosive mixture of this gas with air has the proportion 8.6 : 91.4.

Carpet manufacturers in Europe, who formerly had to send samples of their product to southern countries to test their sun-resisting qualities, now use the mercury-vapor quartz lamp for that purpose, its ultraviolet rays having even greater power to fade dye-stuffs than the sun.

In advertising for proposals for a pressure tunnel for sewage beneath a portion of New

York Bay and Jersey City, it was provided that if water was encountered in such quantity as to render free air methods impracticable, the contractor should have the right to abandon his contract without incurring any penalty.

One of the stations on the newly opened railway from Bandolier Kop to Messina, in the Northern Transvaal, which traverses a region in which great heat is frequently experienced, has been given the name "Ottazel." It is very evident that the name originated with an Englishman.

It is stated that the pumping station for the Jefferson and Plaquemines Drainage District in Louisiana will be the largest in the world, having an ultimate capacity of 900,000,000 gallons in twenty-four hours. There will be installed four 76-in. pumps of 192,000,000 gallons capacity each and two 48-in. pumps of 64,000,000 gallons each per day.

At the Chapin mine, Iron Mountain, Mich., a diamond drill hole was started at 45 degrees and pointing south. It struck ore at 725 feet, corresponding to the eighth level of the mine, if it had continued in the direction in which it was started. Later it was found by the mine workings on the seventh level 96 feet higher and 70 feet south of its supposed position, due to the flattening of the hole.

It is reported from Kearsarge, Mich., that after exhaustive tests the Wolverine Copper Mining Co. has standardized its drill equipment. There are now in use and on order 50 No. 18 Leyner-Ingersoll drills and 16 Jackhamers. This is sufficient for the complete equipment of the property; and operating records at the Wolverine will be watched with considerable interest by other mine superintendents in the copper country, where there is a marked tendency towards standardization

Budapest is the first city in the world to set up slot-machine savings banks. The machines are arranged for the receipt of two coins, the crown, worth about 20c., and the 20-filler piece, worth about 4c. They return a ticket for each coin deposited, and these tickets bear interest from the date of their issuance. The rate paid varies with the current bank rate and ranges from 3 to 4 per cent.; 110 tickets may be exchanged for a bank book.

A wind motor claimed to be the largest of its kind in the world has lately been brought into use at Harlingen (Friesland) for a polder (tract of lowland redeemed from the sea by high embankments) with an area of 1850 acres. This machine, which has steel sails and is mounted on a steel tower, has a diameter of 50 ft. and is said to be capable of dealing with 64,000 to 70,000 cu. ft. of water per hour. Wooden windmills first used for this work were largely superseded by explosion motors, and now the steel "wind motors" are more and more employed.

At St. Johns, Newfoundland, the government has granted a concession for the use of one million h. p. water power at the Grand Falls, Labrador, with which it is intended to generate electricity for the extraction of nitrogen from the atmosphere. Proposals have been made to start a lime-nitrogen fertilizing industry in the Himalaya Mountains, and particularly in Kashmir, where water power is already developed, and lime deposits are abundant. The company is still expanding, and it is expected that the output of nitrate of lime in 1915 will reach 160,000 tons. The Société has also granted licenses for Spain, and works of 25,000 h. p. are being constructed at Lerida.

Telephone apparatus which operates satisfactorily in the United States sometimes develops trouble in the more humid climate of the tropics. The exchanges in the canal zones use electric heaters in the terminal rooms, and lamps in the switchboards, in an effort to keep the apparatus as dry as possible.

Emil Gathmann, of Baltimore, Md., has provided a nozzle for pneumatically operating cotton pickers. It flares outwardly with a funnel shape, and has on its inner side a spiral-toothed rib with a plurality of connected convolutions designed to engage the cotton, dislodge it from the boll and direct it inwardly into the machine.

The evaporative efficiency of oil, if thoroughly atomized in a well designed burner, is considerably higher weight for weight than that of coal. Results of trials show that 1 lb. of crude petroleum with a net calorific value of from 18,000 to 18,250 B.t.u. will evaporate from 14½ to 15 lb. of water from and at [illegible] deg. F

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

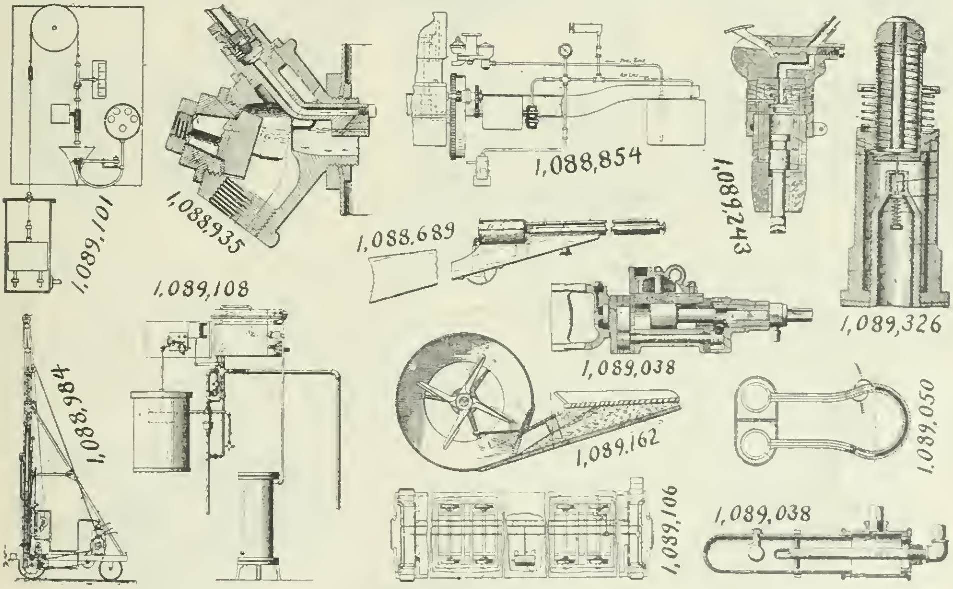
MARCH 3

1,088,689. REPEATING AIR-RIFLE. Arvid Eck, St. Louis, Mo.

1,088,854. FUEL-FEED SYSTEM FOR ENGINES WITH STARTERS. George R. Wadsworth, Cleveland, Ohio.

1. In combination with an internal combustion engine, a fuel supply tank from which fuel is adapted to be forced to the engine by air pressure, an air pump for creating pressure in the tank, and a starter for starting the engine and for actuating the pump.

1,088,860. COMBINED ELASTIC AND PNEUMATIC TIRE. Frederick H. Wilbur, Lestershire, N. Y.



Pneumatic Patents, March 3.

1,088,884. PNEUMATO-ELECTRIC TRACKER-BAR FOR MUSICAL INSTRUMENTS. Charles W. Dorricott, Philadelphia, Pa.

1,088,935. TRACK-SANDER. Walter B. Rogers, Knoxville, Tenn.

1,088,984. ROCK-DRILLING MACHINE. Charles C. Hansen, Easton, Pa.

1,089,033. OIL-BURNER. John Robert Arthur, Roanoke, Va.

1,089,038. PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,089,050. INFLAMMABLE-GAS INDICATOR. Andre Guasco, Paris, France.

1,089,062. BLAST-DISTRIBUTER FOR WINNOWING-MACHINES. Frank F. Landis, Waynesboro, Pa.

1,089,101. FLUID-METER. Harley C. Alger, Chicago Heights, Ill.

1,089,106. CAR-STEP-OPERATING SYSTEM. Fred D. Blake, Charlotte, N. C.

1. The combination with foldable car steps, means for holding the steps in extended position, and means for automatically folding the steps when released, of means operated by *air under pressure* for actuating the holding means to release the steps, and means operated by the application of motive power to the car, for controlling the application of air under pressure to said releasing means.

1,089,108. SYSTEM FOR OZONING LIQUIDS. George F. Butler, Niagara Falls, N. Y.

1,089,243. FLUID-ACTUATED TOOL. Max Maximilian, St. Louis, Mo.

1,089,326. PRESSURE-GAGE. Marvin Logan Chilson, Webster, S. D.

1,089,358. PNEUMATIC PLAYING ATTACHMENT FOR MUSICAL INSTRUMENTS. Robert J. Bennett, Moline, Ill.

MARCH 10

1,089,388. STEEL-GRIT BLAST-MACHINE. Robert J. Barr, Erie, Pa.

1,089,391. BOAT-PROPELLER. Joseph S. Blatzer and Philip J. Pawloski, Pontiac, Mich.

1. The combination with a boat, having a plurality of propeller boxes along each side, of a main propeller and shaft, a plurality of side propellers vertically disposed and ordinarily resting in said boxes, a plurality of cylinders and pistons, one cylinder and piston connected with each side propeller, a means for furnishing compressed fluid to the pistons for forcing the propellers outward, and driving connections on the said propellers and the main propeller shaft for interengaging when the said propellers are forced out by the said pistons and cylinders, substantially as described.

1,089,397. RELIEF DEVICE FOR COMPRESSORS. Rudolph Conrader, Erie Pa.

1,089,414. AUTOMATIC TROLLEY-POLE CONTROLLER. Mark B. Jolliffe, New Haven, Conn.

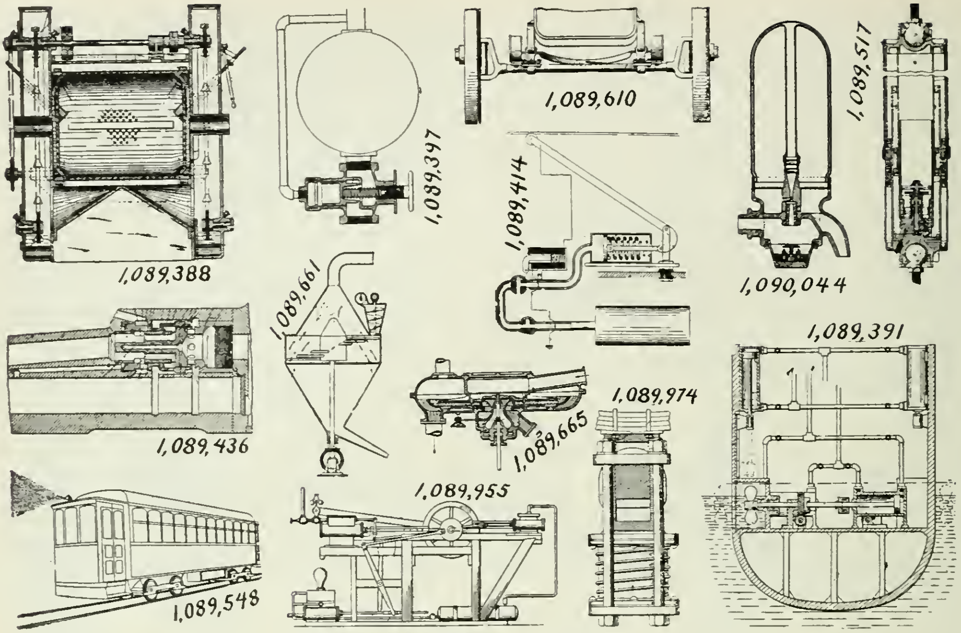
1,089,436. VALVE FOR PERCUSSIVE TOOLS. Caid H. Peck, Athens, Pa.

1,089,517. FLUID-PRESSURE DEVICE. George Westinghouse, Pittsburgh, Pa.

1,089,548. AIR-PURIFIER. Edward L. Gross, Chicago, Ill.

1,089,610. PNEUMATIC SUSPENSION DEVICE FOR VEHICLES. John Williamson, Brooklyn, N. Y.

1,089,652. PNEUMATIC BED-SPRING. John J. Lisbae, Canton, Ohio.



Pneumatic Patents, March 10.

1,089,661. APPARATUS FOR SEPARATING FIBERS FROM OTHER MATERIALS. Paul Hermann Minck, Bremen, Germany, and Edward Carstensen de Segundo, London, England.

1,089,665. CENTRIFUGAL AIR-PUMP. Gustav Pagel, Charlottenburg, Germany.

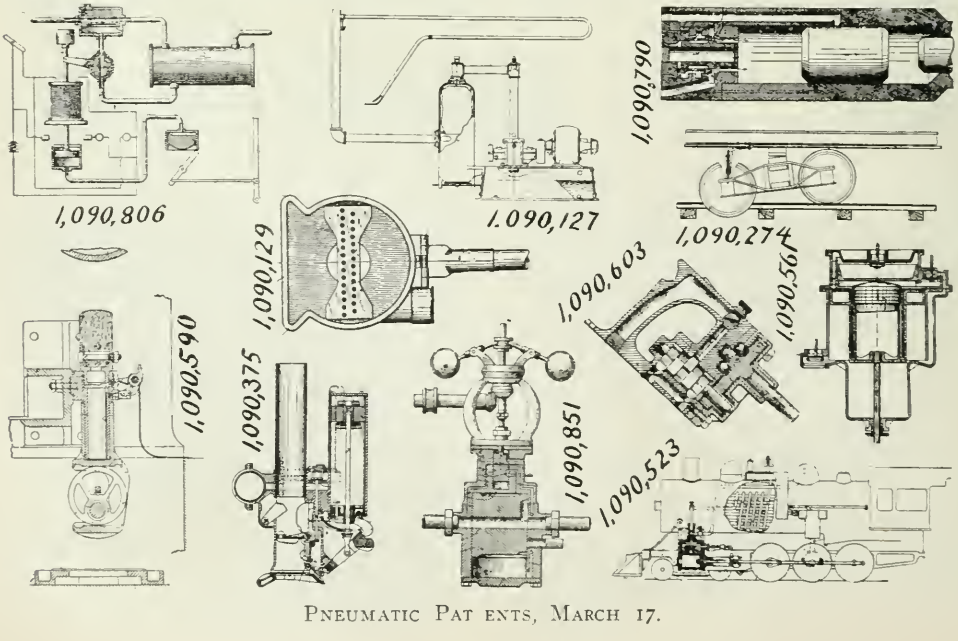
1,089,765. PNEUMATIC PLAYER - ACTION. Emory C. Hiscock, Chicago, Ill.

1,089,800. PNEUMATIC SWEEPER. John G. Stamm, Canton, Ohio.

1,089,955. PUMPING APPARATUS. Samuel J. Peterson, Valdosta, Ga.

1,089,974. PNEUMATIC SUPPORT AND SHOCK-ABSORBER FOR VEHICLES. S. Walter Scott, Troy, N. Y.

1,090,044. SYSTEM FOR TREATING LIQUIDS WITH OZONE. Max Fuss, Frankfort-on-the Main, Germany.



Pneumatic Patents, March 17.

MARCH 17

1,090,127. VACUUM CLEANING APPARATUS. James Thomas Atwood, Rockford, Ill.

1,090,129. SUCTION-CLEANER. Edward M. Barnes, Hastings, Mich.

1,090,274. SAFETY AIR-BRAKE APPLIANCE. Alfred A. Carpenter, Sherman, Tex.

1,090,375. PNEUMATIC-DESPATCH APPARATUS. Thomas Bemis, Indianapolis, Ind.

1,090,523. COMBINED STEAM AND COMPRESSED-AIR ENGINE. Hiram G. Farr, Melrose, Mass.

1. The combination with a steam-driven locomotive having a steam chest and a cylinder supplied thereby, of means mounted on and actuated by movements of the locomotive for storing air under compression, and connections between the stored air and the steam chest for admitting air to the chest at will independently of the steam supply, whereby the cylinder supply may be composed of either steam or air or a combination of both, said connections extending into the steam space of the locomotive whereby the air supplied to the chest will be heated.

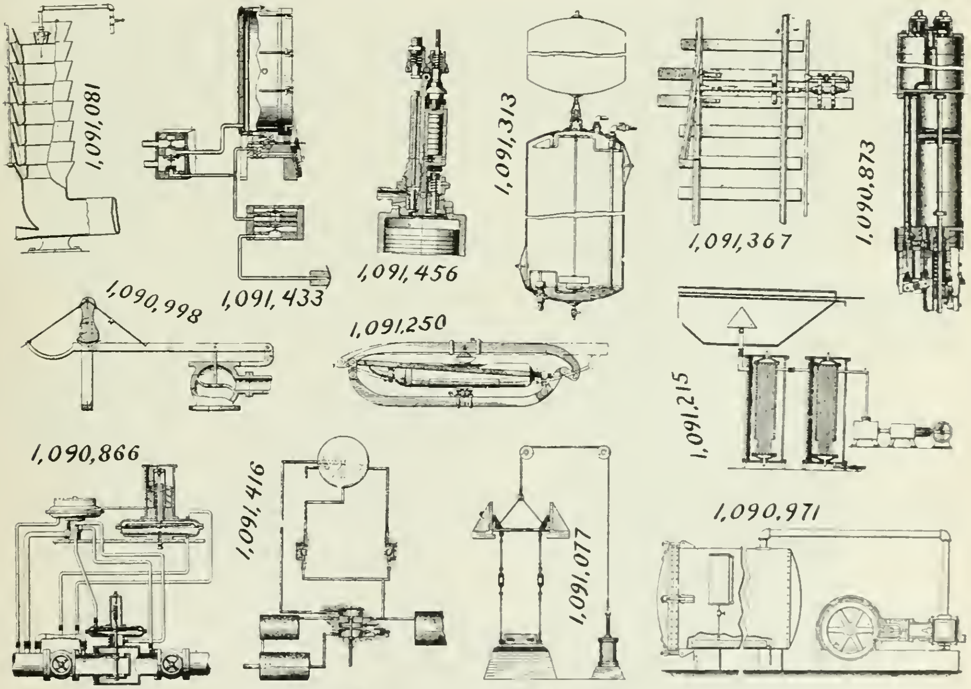
1,090,790. VALVE MECHANISM FOR PNEUMATIC TOOLS. George A. Oliver, Denver, Colo.

1,090,806. AUTOMATIC AIR-BRAKE CONTROL FOR RAILWAYS. Harry J. Warthen, Washington, D. C.

1. An air-brake control device for railway trains, in combination with a fluid-pressure supply and train-pipe, of a piston-valve through which the fluid-pressure passes to the train-pipe, a control-valve for admitting fluid-pressure to the piston-valve, a solenoid having a weighted staff for closing the control-valve, and an electric circuit for the solenoid to open said control valve

1,090,807. DEVICE FOR CONTROLLING THE SPEED OF RAILROAD-TRAINS. Harry J. Warthen, Washington, D. C.

1. A speed control mechanism for use in connection with an air-brake system, comprising a piston-valve through which the air pressure passes for application of the air-brakes, means for admitting pressure to opposite sides of said piston-valve, respectively, and a governor for operating said means.



Pneumatic Patents, March 24.

1,090,561. COMBINED EXPLOSION OR INTERNAL-COMBUSTION AND COMPRESSED-AIR ENGINE. Paul Nolet, Brussels, Belgium.

1,090,590. BEETLING-MACHINE. Thomas Owen Arnfield and William Booth, New Mills, England.

1. In a pneumatic beetling machine a lower movable cylinder, a fixed cylinder, a sliding hammer support inside said fixed cylinder, a hammer on said support to act against a beam the movable cylinder charging the fixed cylinder during its downward stroke and actuating the sliding hammer support on its return stroke to drive the hammer upward to the beam, the sliding hammer support falling by gravity assisted by air suction as set forth.

1,090,603. PORTABLE PNEUMATIC TOOL. Ethan I. Dodds, Central Valley, N. Y.

MARCH 24

1,090,841. ELECTROPNEUMATIC BRAKE SYSTEM. James S. Doyle, New York, N. Y.

1,090,866. PRESSURE-INCREASER. Ernest F. Lloyd, Detroit, Mich.

1,090,873. PNEUMATIC PUMP. Otto R. Pfau, Milwaukee, Wis.

1,090,893. VACUUM-GOVERNOR. Frank W. Van Ness, Milwaukee, Wis.

1,090,907. PNEUMATIC-DESPATCH-TUBE SYSTEM. Fernand E. d'Humy, Englewood, N. J.

1,090,971. METHOD OF AND APPARATUS FOR MOISTENING YARNS. Osborn H. Cilley, Westford, Mass.

1. A method of moistening yarn which consists in placing the yarn in a receptacle having a surface evaporator entirely inclosed therein,

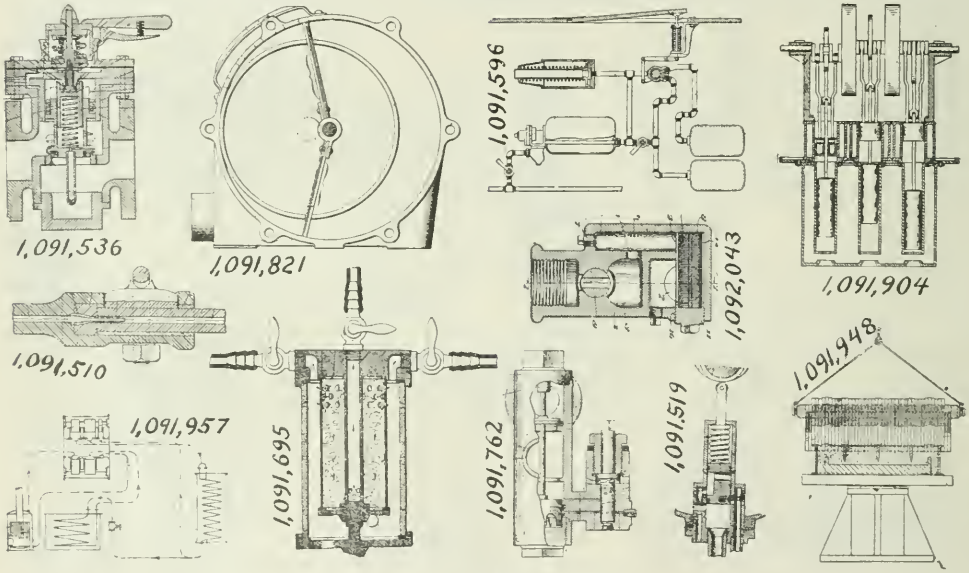
placing a predetermined quantity of water on said evaporator within said receptacle, reducing the air pressure in said receptacle and evaporating the water by heating said evaporator by steam circulating within the evaporator but out of contact with the water therein.

1,090,998. APPARATUS FOR PREVENTING RAILWAY ACCIDENTS. Havard L. Lockart, Philadelphia, Pa.

1. The combination with a railway vehicle having an air brake and a valve casing connected with the air brake, a valve in said casing, a stem on the valve projecting through the casing, a pivoted arm connected to the stem and normally holding the valve in closed position, a cam lever engaging the arm, breakable means holding the lever, and a tripping arm operated in unison with a signal and adapted when the signal is at danger to strike the cam lever and cause the latter to move and permit the valve to open, substantially as described.

1,091,077. JOLT-RAMMING MECHANISM. Edgar H. Mumford, Plainfield, N. J.

1,091,081. STEAM OR AIR BLOWER. Edward Renard, Lewistown, Pa.



Pneumatic Patents, March 31.

1,091,112. FLUID - PRESSURE - OPERATED HAND-TOOL. Lewis C. Bayles, Easton, Pa.

1,091,215. APPARATUS FOR DRYING BY COMPRESSED AIR. Willis E. Hall, New York, N. Y.

1. An apparatus for drying by compressed gaseous fluids, comprising a fluid compressor, a moisture separator for eliminating moisture from said fluid, a chamber for collecting such fluid after said elimination has taken place, a means for bringing the fluid to a predetermined temperature and a controlling device arranged to permit the ejection of said compressed dried fluid at a predetermined pressure, said compressor, moisture separator, chamber, means and controlling device being in communication with each other.

1,091,250. PNEUMATIC SUSPENSION FOR VEHICLES. William Sellenger, Richmond, Victoria, Australia.

1,091,313. AIR-COMPRESSOR. Carl H. Erickson, Denver, Colo.

1,091,367. PNEUMATIC DERAILER. John J. McIntyre, Uniontown, Pa.

1,091,383. VACUUM-CLEANER. Ulysses C. Oblosser, Bloomsburg, Pa.

1,091,416. AIR-BRAKE. Andrew J. Wisner, Philadelphia, Pa.

1,091,433. SNARE-DRUM DAMPER. Robert Hope Jones, North Tonawanda, N. Y.

1,091,447. PNEUMATIC TOOL. Lawrence Lee Wagner, Lakemont, Pa.

1,091,456. AIR-PUMP. Carl E. L. Lipman, Beloit, Wis.

MARCH 31

1,091,510. CHUCK FOR ROCK-DRILLS. Charles C. Hansen, Easton, Pa.

1,091,519. ENGINE-STARTER. Charles M. Leech, Lima, Ohio.

1. The combination with an internal combustion engine comprising a cylinder, a piston operating therein, a closed crank case, a crank shaft, and a pitman connecting the piston and crank shaft, of means to supply compressed air into the crank case to move said piston in one direction, and means automatically operated by the movement of the piston to cut off the supply of compressed air from the crank case and establish communication between the interior of the same and the atmosphere, so that the piston may move in a reverse direction.

1,091,529. PUMP AND AIR-COMPRESSOR. Lewis Hallock Nash, New York, N. Y.

1,091,536. PRESSURE-REGULATING VALVE. William Ross, Troy, N. Y.

1,091,596. LOAD-CONTROLLED AIR-BRAKE. Jacob Rush, Snyder, Pittsburgh, Pa.

1,091,695. AIR-FILTER. Paul E. Nolden, St. Louis, Mo.

1,091,762. HIGH-PRESSURE RELEASE-VALVE. Frank Phelps, Little Rock, Ark.

1,091,821. ROTARY PNEUMATIC PUMP. Frederick C. Fesenbek, Philadelphia, Pa.

1,091,904. HOT-AIR MOTOR. Ernest A. Wullenweber, Detroit, Mich

1,091,948. SAND MOLDING APPARATUS. Edgar H. Mumford, Plainfield, N. J.

1,091,957. APPARATUS FOR REFRIGERATING BY MEANS OF LIQUEFIED GAS. Frederic Augustin Pollard, Parc St. Maur, France.

1,092,043. CROSSOVER CONNECTION FOR FLUID-BRAKE SYSTEMS. Walter F. Hammond, Rocky Mount, N. C.

COMPRESSED AIR
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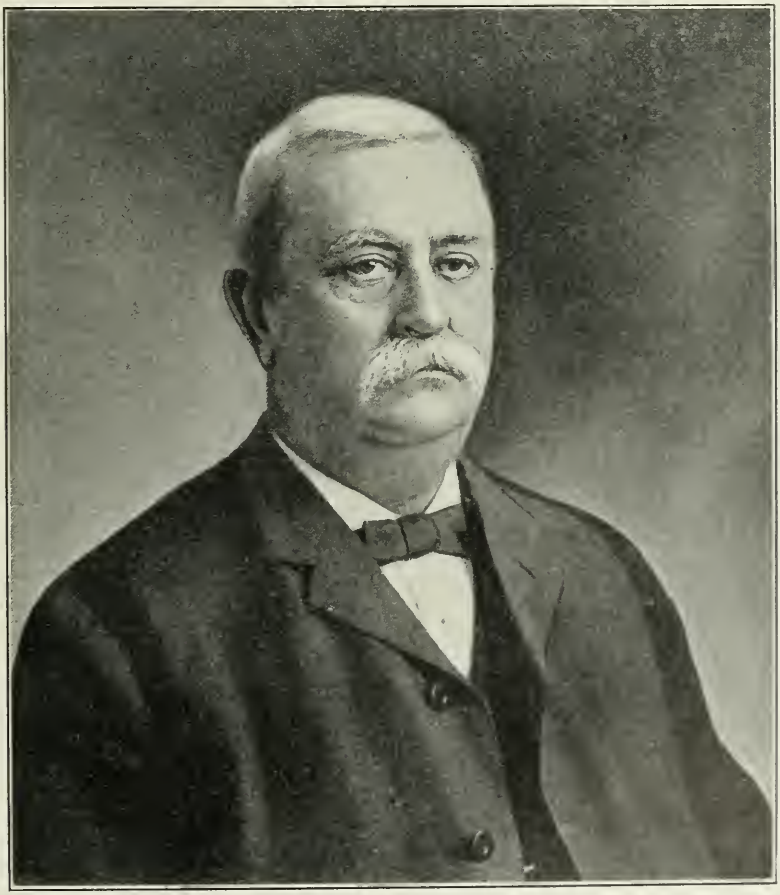
EVERYTHING PNEUMATIC.

Vol. XIX JUNE, 1914 No. 6



A Noble

ALFRED NOBLE

Alfred Noble, one of the great engineers of America, with a record of vast experience and of a wide range of work accomplished, personally loved and honored by those who knew him, died in New York, with but little warning on April 19, just as he had completed his threescore years and ten.

The record of his life speaks for itself, and no eulogies can augment it. He was born a farmer's boy in 1844 at Livonia, Wayne County, Michigan, which was then one of the State's latest admitted to the Union. Though a pioneer State it started with a fine public school system of which the boy was a beneficiary with the rest.

The great war and the work of saving the Union, however, became for a time the paramount consideration, and in the second year of the war, when eighteen years old he enlisted in the Twenty-fourth Michigan, in which he went through the severest service. On the first day at Gettysburg his regiment lost 300 in killed and wounded out of 460 who went into the fight. He was discharged at the close of the war with the rank of sergeant, and his veteran record led the way to a clerkship in the War Department.

He was earning money and also studying, so that after a year or so he was able to enter the University of Michigan as a sophomore, and was graduated in 1870 as a civil engineer. While in college he had been earning his way by outside work, chiefly as a recorder and assistant engineer in harbor work on Lake Michigan, conducted by the U. S. Corps of Engineers, and the year of his graduation he was placed in local charge of the improvement of Sault Ste. Marie. After twelve years, which saw the completion of the great lock, he resigned and then supervised the construction of the truss bridge over the Red River at Shreveport, La.

Early in 1884 he became assistant general engineer of the Northern Pacific Railroad, and during the next three years he had charge of the building of many important bridges and viaducts on that system. Then he had charge of the erection of the magnificent Washington bridge across the Harlem River, then the largest arch bridge in the world. After that there was the erection of a great bridge across the Ohio at Cairo, a cantilever bridge over the Mississippi at Memphis and other bridges at Bellefontaine, Leavenworth and Alton.

In 1895 Mr. Noble was appointed by President Cleveland a member of the Nicaragua Canal Board. The Board examined in detail both the Nicaragua and the Panama routes, completing its work November 1895. In June, 1899, he was appointed by President McKinley a member of the Isthmian Canal Commission, charged with the selection of the best route, and that finally determined upon was practically as selected by this commission. While charged with this duty Mr. Noble with his colleagues visited Europe to examine the canals there and also made several trips to Central America.

In 1905 he was appointed by President Roosevelt a member of the International Board of Engineers to recommend whether the Panama Canal should be a sea-level or a lock canal, the board consisting of thirteen members, of whom five were nominated by foreign governments. Mr. Noble was one of the minority of five Americans who recommended the adoption of the lock plan, and it is said that the reading of a letter of Mr. Noble before a committee of Congress determined the favorable action of that body.

In March, 1907, he was one of three appointed to visit the Canal to investigate the conditions regarding the foundations of some of the principal structures. This duty was completed in a few weeks, but within that time he suggested new and ingenious devices for definitely determining the safe foundation pressures. Mr. Noble was continuously identified with the canal project, and he deserves as much credit for the solution of the engineering problems as any other one who has been associated with the work.

Other great engineering responsibilities were sandwiched in with these sketched above. In July, 1897, he was appointed a member of the U. S. Board of Engineers on Deep Water Ways, which made elaborate surveys and estimates of cost for a ship canal from the Great Lakes to the Hudson.

He was appointed with Henry C. Ripley and General Robert as a Board of Engineers to devise a plan for protecting the city of Galveston from inundation. They recommended the building of a solid concrete wall over three miles long and seventeen feet high, the raising of the city grade and the making of an embankment adjacent to the wall, and the work was executed by him in partnership with Ralph Modjeska.

Perhaps the most important of Mr. Noble's labors, as that by which he became best known, was as a member of the board directing the operations of the Pennsylvania Railroad in tunneling under the North and East Rivers and under Manhattan and the construction of the great station on Seventh Avenue. Besides serving as a member of the board, Mr. Noble was chief engineer of the East River Division, and directly in charge of the construction of the tunnels under Manhattan and the East River, and their related terminals on Long Island. This may be regarded as one of the most difficult engineering undertakings ever successfully accomplished, although the general public had no means of realizing it.

Since the completion of that work Mr. Noble has been in general consulting practice, serving also on retainer as consulting engineer for the New York Board of Water Supply. Only last year the Federal Government charged him with an important service. The construction of a drydock at the Naval Station, Pearl Harbor, Hawaii, had come to disaster by the eruption of the bottom, and Mr. Noble was sent to advise as to how the work should be completed. He reported for the Canadian Government upon the enlargement of the Welland Canal. The Public Service Commission of New York which is building a $165,000,000 subway system also called for his services in consultation.

Mr. Noble never posed for publicity, but recognition of his abilities and of his great engineering works accomplished was inevitable, especially from those best informed and most competent to judge. His own University of Michigan in 1895 conferred upon him the degree of Doctor of Laws, the same honor coming to him from the University of Wisconsin in 1904. He was president of the Western Society of Engineers in 1898, and of the American Society of Civil Engineers in 1903. The John Fritz medal was presented to Mr. Noble in 1910. The same year he was elected an Honorary Member of the Institution of Civil Engineers of Great Britain, a distinction held by no other American. In 1912 he received the Elliott-Cresson Medal of the Franklin Institute "in recognition of his distinguished achievements in the Field of Civil Engineering."

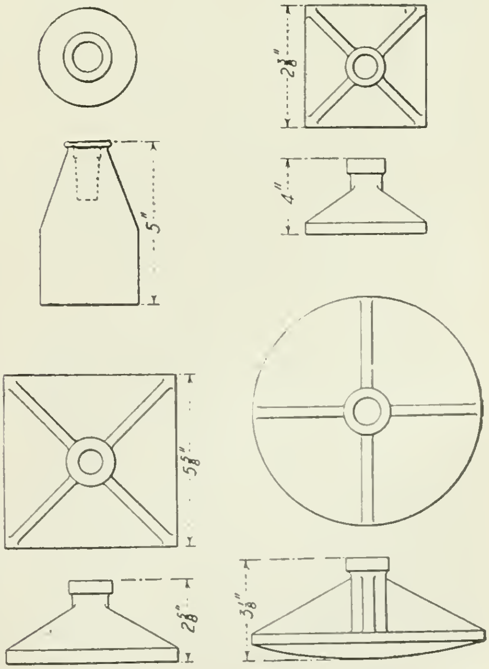
Mr. Noble was deeply interested in elevating the status of the engineering profession and took an active part in the organization of the American Institute of Consulting Engineers. He was especially kindly and helpful to the younger and rising members of the profession. He was universally respected by all who had business dealings with him, he commanded the faithful and enthusiastic loyalty of his subordinates and the sincere affection of those who came most near to him.

PNEUMATIC RAMMERS FOR CONCRETE

BY CHARLES A. HIRSCHBERG.

Pneumatic rammers are used in all up-to-date foundries for ramming molds, and have reduced labor and costs and improved the product. It is only recently, however, that they have been employed in such work as tamping earth around gas and water mains, building roads, constructing concrete buildings, making concrete pipe, artificial ashlars, steps and pillars and ramming concrete walls in tunnels.

Lower cost and greater speed are not the most important factors to be considered in this class of work. The improved quality of



BUTTS FOR RAMMING CONCRETE.

the pneumatically finished product over that rammed by hand is such that contractors, particularly in France, Germany and Belgium, are resorting to the use of the pneumatic rammer in the interests of safety and lasting attributes.

In the accompanying photograph are shown a number of Crown pneumatic rammers at work on a large concrete palace constructed last year at Nancy, France. This rammer is of the same general construction as the rammer used in foundry work, although the butt is different. In the drawing are shown several shapes of butts used for ramming concrete. The large butt is employed for general work and the small square one for working in corners and restricted areas. The round butt is used occasionally. Butts for ramming concrete are generally made of cast steel. For finishing the work and to avoid the spraying of the semi-liquid cement the butts are made of rubber, hard wood and occasionally of fiber.

The rammer is equipped with a trigger throttle by means of which its entire operation is controlled. In general construction this tool is simple; a valve of the spool type works in a hardened-steel valve box which is clamped between a cylinder and head block from which an extension tube or pipe leads to the throttle. There is also a piston, to the outer extremity of which a butt is attached. An air hose is connected at the top of the rammer. With the exception of the butt, all parts are generally made of steel. A tool such as that shown consumes approximately 24 cu. ft. of free air per minute at 80 lb. (with the throttle wide open) under which pressure it is usually operated. It strikes approximately 600 blows per minute at this pressure.

RECORDS OF PERFORMANCE.

The average performance of one rammer operated by one man over a ten-hour period is 270 sq. ft. of surface rammed. In the making of big pillars it rams easily 212 cu. ft. in ten hours. The finished product is much superior in quality to that rammed by hand.

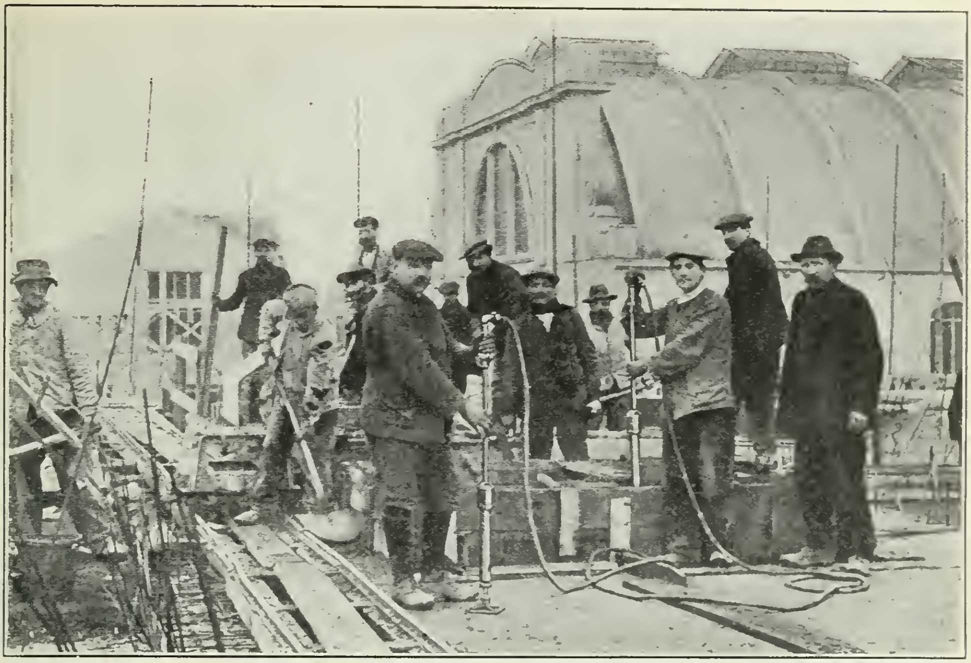
A Belgian engineer, who has made a study of this subject, found that in the ramming of concrete the number of blows struck played a far more important part than the power or strength of the blow. Such being the case the mechanical rammer, which strikes approximately six hundred light blows per minute, is ideal in comparison with hand work. In one experiment on comparatively small cubes it was demonstrated that sixty blows gave the concrete a resistance of 2,844½ lb. per square inch; forty blows, 2,460¾ lb. per square inch, and twenty blows, 1,538 lb. per square inch. A similar test with hand-ramming gave a resistance of only 939 lb. per square inch. The hand rammer used weighed 33 lb. and was permitted to fall from a height of 20 in.

Expert workmen handling the hand rammer are unable to strike more than fifty blows per minute and maintain that speed for any length of time. It was shown that the same workmen using pneumatic rammers under an operating pressure of somewhat less than 80 lb. were able to maintain a maximum of four hundred blows per minute over a considerable period. It is also possible to vary the number of blows at will, reducing them to as few as three per minute.

Further tests demonstrated that the pneumatically rammed concrete is much more dense than hand-rammed concrete and that one man and a pneumatic rammer would do approximately the work of five men working by hand. In the case of one study it was found that one man operating over a large area of concrete was able to cover 1,076 sq. ft. of surface in ten hours. Experiments conducted in the manufacture of concrete pipe in the neighborhood of Paris showed a saving of 50 per cent. in the cost of production.

As on the majority of such work, air power is a part of the contractor's equipment, for the operation of temporary pneumatic lifts, riveters, etc., the use of pneumatic rammers does not entail any outlay for temporary power plant equipment, and it would seem that the results obtained by their adoption are such as to warrant greater interest on the part of the contractor. The type of rammers illustrated in this article is manufactured by the Ingersoll-Rand Company.—*Engineering Record.*

Nitrogen over one square mile of the surface of the earth—including land and sea—is estimated to be sufficient to supply the whole world with fertilizer, at the present rate of consumption, for fifty years, and while the fertilizer was running its course, supplementary nature processes would be returning the nitrogen to the atmosphere again.



CROWN PNEUMATIC RAMMERS AT NANCY, FRANCE.

PNEUMATIC TOOLS

BY H. S. HUNTER.*

It is my pleasure to give you to the best of my ability a brief history of the origin and development of portable pneumatic tools. By "portable" I mean machines that can be conveniently carried around in the hands of the operator; I do not refer to pneumatic tools or machines of stationary or semi-stationary types. The power used to operate pneumatic tools, as the word implies, is compressed air generated by an air compressor which may be direct driven either by steam, gas, gasoline, electric motor, water power or by belt from any of these sources of power. The air pressure usually carried is from 80 to 100 lbs. per square inch. Steam cannot be used conveniently to operate portable pneumatic tools, as the temperature rise of the machine would be such that the operator could not hold it.

The air is conveyed from the compressor, or from a receiver used to overcome the pulsations of the compressor, through a pipe line to within 40 or 50 ft. of the work, depending on the radius of operation desired, and then through a flexible hose to a connection on the tool. The tool is provided with a throttle valve within the touch of the operator, which enables him to start and stop the machine without releasing his hold.

Pneumatic tools may be divided into two classes: the percussion motor, or what is commonly called the pneumatic hammer, and the rotating motor, commonly called the pneumatic drill or reamer.

As is the case with a great many of our modern labor saving devices, we owe the original idea of portable pneumatic hammers to England, but it rested with us to develop this idea and put it into practical use. The original pneumatic hammers were used for filling teeth. They were known as pneumatic dental pluggers, and to this day are used by a great many dentists for this purpose. From the miniature dental pluggers of 30 or 40 years ago the present portable pneumatic hammer has been developed.

It is rather difficult to convey in words the mechanical principles employed. You can imagine, however, an air gun, the bullet of which would correspond to the piston of a pneumatic hammer. Suppose we place in the forward end or muzzle of the gun the shank or end of a piece of steel which is provided with a shoulder that will allow it to enter the muzzle only a given distance, the opposite end of the steel is dressed or machined to suit the work we wish to do. In the case of driving rivets the steel would be cupped to form a rivet head. If we wished to chip or cut iron or steel we would shape the forward end of the steel like a chisel and so on for any work, such as beading flues, calking boilers, carving marble, stone, etc. The operator places the forward end of the steel against the work and presses the trigger or opens the throttle valve, and holding it open, the piston is projected forward in the cylinder striking the shank of the steel. The instant the blow is struck the piston is returned to the rear of the machine for the next stroke. This forward and return movement of the piston is controlled by an automatic valve placed in the rear of the cylinder, the valve in turn being actuated by the piston through communicating air ports. The number of blows struck per minute ranges from 400 to 11,000, depending on the size, length of stroke and type of tool.

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*From a paper before the Fellows' Club, Pittsburgh.

A fertile field for the use of pneumatic hammers in their early stages was calking the seams of steam boilers and other vessels built to withstand pressure. Before the introduction of pneumatic hammers no mechanical means were in use for this purpose, and the average day's work of 9 hours for a man was about 85 lineal feet, while 390 ft. is not an exceptional day's work with a pneumatic calking hammer.

Two hundred and fifty rivets per day was considered a fair day's work for a crew of 3 men and a rivet-heater boy, while 2,000 rivets are being driven per day by a crew of 2 men and rivet-heater boy with a pneumatic riveting hammer. Besides, considerable skill is required to drive a tight rivet by hand, while only ordinary intelligence is required to apply the pneumatic hammer.

Portable pneumatic motors or drills are a modern adaptation of the steam engine, differing only in application. They are built in three types, the reciprocating piston, the rotary and the turbine principles being used; the former, however, seem to have the preference, due no doubt to the more compact form possible with this principle. They are designed to develop the maximum power with minimum weight and to meet the specific requirements for which they are built.

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pneumatic drill weighing 40 lbs. will do the work of a modern stationary upright drill press weighing 1,800 lbs., and that pneumatic hoists will lift a weight corresponling to 2,500 times their own weight one foot high in one minute with 90 lbs. air pressure. The modern portable pneumatic riveting hammer will develop power equal to 3,800 times its own weight in one minute with 100 lbs. air pressure, or a machine weighing 22 lbs. will develop 2½ H. P., and continue to develop this power indefinitely, in spite of the extreme adverse conditions under which they are sometimes used.

Some users complain of the maintenance cost of pneumatic tools, but when the enormous power developed compared with the weight of machine is considered, as well as the class of labor usually employed to operate them, there is an excuse for a somewhat higher cost of maintenance than would be the case with other types of machinery.

The pneumatic tool is perfectly satisfied to be judged by the quantity and quality of its work as compared with any other device or tool made and when final results are considered the cost of maintaining pneumatic tools dwindles into insignificance.

GAS TO BURN IN THE FOUNDRY

The gasworks in the town of Heinichen, Germany, is co-operating with a local foundryman for the utilization of gas for starting the latter's cupola furnace, etc. The necessary burner, made in the foundry itself, is used not only for lighting up, but also for core-drying, mold-drying, and the like; no other means being employed. To know how much gas is used, and to prevent unnecessary consumption, there is attached to each burner a "penny-in-the-slot" meter. For lighting the cupola once, there is required 1,800 liters (64 cu. ft.) of gas, which at the regular price of 17 pfennigs per thousand liters ($1.11 per thousand cu. ft.) costs about 30 pfg., or seven cents. Lighting the driers costs about two-thirds as much. The saving is not only in the cost of the materials used in combustion, but also in time required for splitting the wood, and the like; and there is no more complaint from the neighbors on account of smoke.

THE GANG AT THE HEADING.

A RECORD OF RAPID TUNNEL DRIVING

BY FRANK RICHARDS.

The tunnel here to be spoken of, recently completed, constitutes an important addition to the waterworks system of St. Louis, Mo. It extends from the existing pumping station at Chain of Rocks on the Missouri shore of the Mississippi to an intake near the Illinois shore of the river. There is of course a shaft at each end of the tunnel and another close to the river bank from which the tunnel was driven in both directions, 537 feet of it being under the land and 2252 feet under the water, although the rock is practically the same from end to end, a hard limestone, which drills well, except for the fact that it is full of horizontal seams, which makes it extremely blocky.

The working shaft was 96 ft. deep, 32 ft. in earth and the remainder in rock. It was circular, 12 ft. diameter in the earth and 10 ft. diameter in the rock. The tunnel, 10 to 11 ft. diameter, was driven as a single heading in each direction from this shaft. There was left 1.5 to 2 ft. of loose muck in the bottom of the tunnel for all of the work except the last 600 ft. of the river tunnel where the bottom was raised slightly to pass over a water seam. Even then, however, about 3 ft. was left in the bottom, of which about a foot was hard rock.

Both headings were driven at once until the shore tunnel was finished, after which one heading was continued until the end. The headings were turned Sept. 26, 1913, and the 537 ft. of land tunnel was completed Dec. 17. The river tunnel was completed March 4, 1914. During the time there were several shutdowns, the longest of which was about ten days.

Four C-110, Butterfly valve, Ingersoll-Rand drills, pistons 2¾ in. diameter, were used at each heading. At first these were mounted on two 7 ft. columns with arms. At that time each 8 hr. shift mucked out, set up, drilled and shot once, making 3 shots in 24 hours. Later on four shots were made in the same time: one at 8 A. M., then at 2 P. M., 8 P. M. and 2 A. M., still using the two columns.

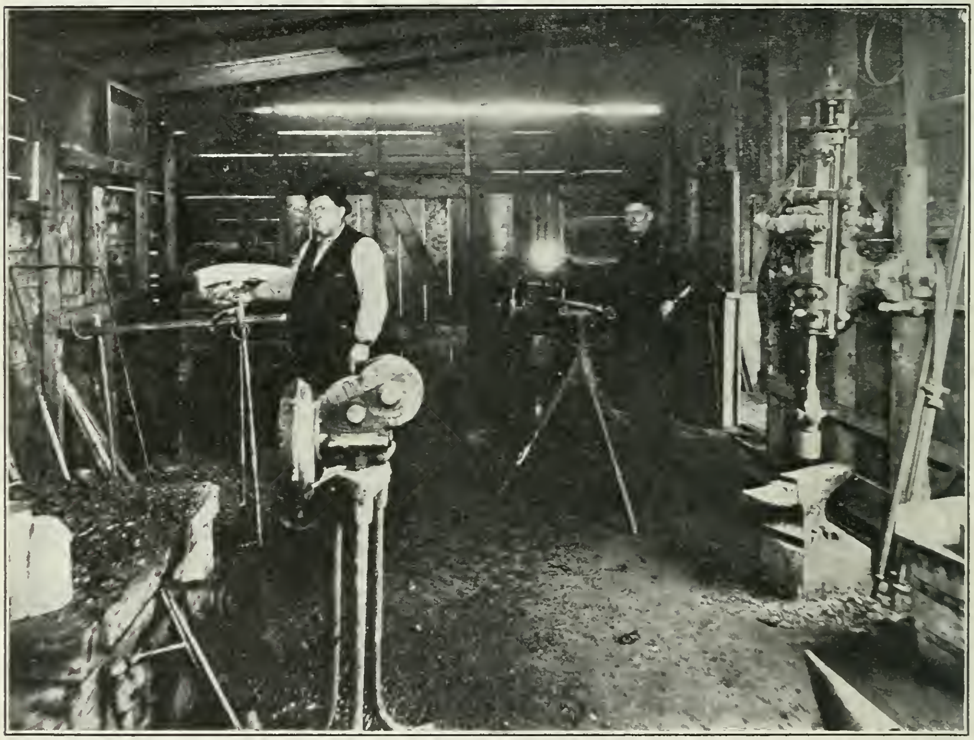
On Feb. 21 a schedule of two shots per shift, or 6 shots in 24 hours, was started. Under this arrangement a single shaft bar was used 4½ in. diameter and 10 ft. long with four arms. The bar was set up about a foot above the spring line of the tunnel, and the entire heading was drilled from the one setting. To steady the bar a special arm was made with a jackscrew in the end of it. This was placed in the middle of the bar and the screw set up against a block below and somewhat behind the bar, see half-tones.

At the beginning of the work as many as 22 holes were used to break the ground, but this was finally brought down to 16 holes, distributed as follows: Six cut holes, three on a side, one breakdown hole above the cut, one center and two rib dry holes, and seven side-round or trimming holes. The cut holes were drilled 6 to 7 feet deep and the other holes from 4 to 6 feet.

In trimming the tunnel three Jackhamer drills were used for the sides and bottom, while the roof was drilled with a BC-20 (Butterfly) stope drill. The entire 2789 ft. of tunnel was practically ready for concrete 26 days after holing through.

DRILL SHARPENING.

There were used from 120 to 200 pieces of steel per day, and these were made and sharpened on a Leyner Drill Sharpener by one blacksmith and one helper, working on 8 hr. shift. They also attended to all general work for both the tunnel and the caisson work in the river. In the photo of the blacksmith shop the drill sharpener is in the extreme back ground, right center, while at the extreme right we see a rock drill which has been rigged up as a power hammer.



TOOL SHARPENING SHOP.

RATE OF PROGRESS.

The rate of progress at first, with three shots in 24 hours, was about 103 ft. per week of seven days, on the four shots it was 132 ft., and with the six shots it was 175 ft. or better. For the week ending 8 A. M. Feb. 20, the progress was 184 ft. or about 26.3 ft. per day. For the month ending at 8 A. M. Feb. 21 the progress was 744.7 ft. of tunnel. The figures for the monthly and weekly progress are be lieved to be a new record for the United States.

The best shift's work was 12.2 ft., the best day's work was 29.1 ft. and the best single shot while on the six-shot schedule was 6.6 ft. One of the drill runners in the heading drilled 42.1 linear ft. of holes in 100 minutes, and the time for drilling on entire round of about 108 ft. of holes was from 100 to 120 minutes.

The screen chamber shaft, at the land end of the tunnel, was sunk with one Jackhamer drill, which furnished muck for 8 to 12 men. On one occasion, when there was a smooth bottom to work on, the one man drilled 42.6 ft. holes and shot them in an 8 hour shift.

In this important extension of the St. Louis water supply there were other problems involved besides the driving of the tunnel, notably the building of a coffer-dam in the river and the sinking of the shaft for the intake. The entire work was handled, including the designing as well as the execution of it, by C. H. Hollingsworth as General Superintendent for the Fruin-Colnon Contracting Company. With him in charge of the three shifts were C. H. Sleight, W. B. Converse and J. M. F. Burkman, with R. E. Mosier in charge of the screen chamber work.

Mr. E. C. Davis was Resident Engineer for the city of St. Louis, and to him we are indebted for the progress data here given. One of his inspectors measured the work after each shot and the progress was minutely recorded.

DESIGNATING THE WINDS

The Beaufort scale will be used hereafter by the Weather Bureau in designating wind velocities in weather forecasts.

BEAUFORT SCALE.

Force.	*Designation.*	*Miles per Hour.*
0	Calm	From 0 to 3
1	Light Air	Over 3 to 8
2	Light Breeze	Over 8 to 13
3	Gentle Breeze	Over 13 to 18
4	Moderate Breeze	Over 18 to 23
5	Fresh Breeze	Over 23 to 28
6	Strong Breeze	Over 28 to 34
7	Moderate Gale	Over 34 to 40
8	Fresh Gale	Over 40 to 48
9	Strong Gale	Over 48 to 56
10	Whole Gale	Over 56 to 65
11	Storm	Over 65 to 75
12	Hurricane	Over 75

METHODS AND COSTS OF DRY DOCK EXCAVATION ON THE PANAMA CANAL

BY G. H. GILBERT.

The condition of disintegration of material that is to be excavated is the circumstance that, in the main, will determine the quantity that may be removed in a given time by a steam shovel. This disintegration of material when effected by means of explosives will result in the production of larger or smaller fragments, depending upon the geological formation, the quantity of explosive employed, the diameter, depth, and relative positions of the blast holes.

On the Panama Canal work, the greatest quantity of dry rock excavated by steam shovel was from the Central Division, which division included the great Culebra Cut, and this division will be taken as typical of the practice and methods employed on the Isthmus.

The geological formation of the Central Division consists, in the oldest rocks, exposed between Bas Obispo and Empire, of an extensive meta-conglomerate at Bas Obispo, overlain by a series of variegated volcanic agglomerates, tuffs, lava flows, plugs, dikes, and volcanic breccias, mostly of basic character. These formations are all much faulted and sheered A 500-foot downwarp or sag, the northern rim, which is at Empire, is of breccia (an aggregate formed of angular fragments united by a matrix or cement;) the southern rim, at Paraiso, is basalt intrusions and breccias. This downwarp is not now a valley but is filled in with a land-deposited formation of very fine grained green volcanic clay, and the latter intruded by basalt and breccias. The downwarped rocks consist of dark, soft and friable, thinly bedded, carbonaceous shales and clays, containing lenses of gravel, sand, marl, and waterlain basic tuff (scoria and ashes.) This formation is estimated as 250 feet thick. It grades upward into the next younger formation, which consists of light gray, limy sandstone and sandy limestone beds and lenses, three inches to three feet in thickness, separated from each other by thin beds of friable marly shale, with considerable carbonaceous matter, locally. These formations show fossil oysters, gastropods, corals and foraminifera, all remains of a marine fauna. Pyrite occurs locally in these beds, and where there are layers of carbonaceous material it has, on exposure to the atmosphere through blasting, generated sufficient heat to ignite wood.

The chief characteristic facts about these series of bedded rocks are their low crushing strength and comparative weakness, and their subjectivity to weathering and erosive processes. The last marine bed of rock is a shell and coral limestone, found at intervals across the Isthmus. Overlying most of the above described beds is a subaerial deposit, over 400 feet thick, of fine grained basic volcanic clay rock, which fills the downwarp in the marine beds.

This formation, locally, contains lenses and beds of gravel, sandstone, carbonaceous and lignitic shales in beds up to four feet thick and an extensive flow of lava twenty feet in thickness. The whole formation is very weak, crumbly, and easily weathered. This general geological description applies to the Central Division and includes all the very heavy cuts between Bas Obispo and Paraiso and comprising the Culebra and all other work on the division.

The operations during the year 1911-12 were fairly representative of the best operating conditions of excavation. During this period over 17,000,000 cubic yards were excavated from this division, of which over 84% was classified as rock. A further arbitrary classification of all rock excavated was 80% soft rock and 20% hard rock; these classifications were changed to the more general classification of blasted material. A review of the geology of the division will show the difficulties of even an approximate classification of the widely differing materials and their respective quantities.

The weak and crumbly "soft rock," in its unstable condition, would be disturbed readily and dislodged into an open cut by using dynamite in the minimum quantity in blasting. The common effect of an explosion was the dislodgement of great masses of this already disintegrated material, which upon impact with the bottom of the cut would be broken up still more and be in condition to be readily excavated by steam shovel. It is in material of this nature that the abnormal quantities have been excavated by steam shovel. A record has been established by one shovel of excavating and loading 4,465 cubic yards in eight hours. This was a 95-ton Bucyrus machine. The same shovel dug the record quantity for one month of 70,290 cubic yards. Another shovel of the same size and make has established a record for a year's work of 543,481 cubic yards, the machine working 295 days. These records are no criterion of the usual performance of these machines, the records being made under the most favorable conditions that may be arranged.

During the year 1911-12 there were employed on the Central Division, 46 steam shovels of the following makes and sizes: 20 Bucyrus 95-ton shovels with buckets of 5 cubic yards capacity; 10 95-ton shovels with 4 yard buckets, 7 70-ton with 3 yard buckets, and 2 45-ton with 1¾ yard buckets. Of the Marion Co.'s make there were 7, Model 91, with 5 yard buckets. These 46 steam shovels excavated, in rock and earth, approximately 17,000,000 yards, an annual average for each shovel of 370,000 yards. The average monthly output was 33,000 yards, the daily output 1,318 yards, and the hourly output, while under steam, about 165 yards.

In addition to the advantages accruing from the use of powerful shovels with very large capacity buckets, the transportation methods and equipment for the disposal of the excavated materials, were a factor contributing to the large output of the steam shovels. Flat cars of 19 cubic yards capacity, were very generally used to transport the excavated material to the spoil banks or dumps. These cars were unloaded by means of a power operated plow or unloader. These cars were of the Lindgerwood Co.'s build. In a lesser degree, dump cars of 10, 17 and 24 cubic yards capacity were employed in filling in from trestles and other similar situations.

The large flat cars permit of very rapid loading and unloading without the common delays experienced with dump cars, of the larger fragments jamming and binding in the body and doors. The type of equipment, the large size of the cars, and the large number of cars and locomotives always available enabled the steam shovels to be kept at work without the usual serious delays caused by waiting for the removal of loaded cars or the return of unloaded ones. During 1912, a total of 12,863,000 cubic yards of blasted material was excavated from the Central Division. There were in use on the division, 150 well drills and 230 tripod percussion drills.

The formations of a soft and open nature,

TRIPOD DRILLS AT PEDRO MIGUEL LOCKS.

permitted the rapid sinking of blast holes of large diameter, by the oil well type of gravity drill. The well drills were ordinarily operated in the loose friable materials and where there was an overlay of earth, and lenses and pockets of sand and gravel. To prevent the earth, sand or gravel from filling in and blocking up the holes during the drilling process, pipes or casings of iron were driven in the hole as the bit penetrated. This added to the cost of the process. The holes drilled were 5 inches in diameter and 19 feet in depth, as an average. The average number of feet drilled per day per well drill was 50 feet at an operating labor cost of 6.68 cents per foot.

In the hardest rock, such as basalt, the igneous rocks and dikes, the tripod percussion drills were employed. The average number of feet drilled per day per tripod drill was 41 feet, at an average operating labor cost of $0.0896. In drilling horizontal or toe holes, the tripod drills were of necessity employed. To blast approximately 13,000,000 yards 5,000,000 linear feet of blast holes were drilled. The average quantity of material blasted to each foot of drilled blast hole was 2 3-5 cubic yards. The aggregate length of holes drilled by well drills and by percussion drills was about the same.

WELL DRILLS AND PERCUSSION DRILLS COMPARED.

As a basis for an adequate understanding of the comparative performances of the well drill and of the percussion drill, it will be necessary to make comparison of the mechanical performance and the useful work performed in a given time, as the work appropriate to either type is in entirely different formations and under differing operating conditions.

The function of a well drill is to sink a well or hole of comparatively large diameter through mixed or loose formations, in which may be placed a large quantity of slow acting explosive. The holes, in accordance with the nature of the strata are drilled at comparatively great distances between centers, 15 to 25 feet as governed by the depth of cutting and the nature of the formations penetrated. The surrounding conditions most favorable to the operation and employment of the well drill are where the formations being penetrated are of an open and friable nature or where there is an overlay of earth, and where the material to be blasted is in a naturally unstable condition and requires but to be shaken or disturbed by the eruptive action of a large volume of gas resulting from the explosion of slow acting or low-power dynamite in quantity, to separate, or disintegrate the mass sufficiently to allow it to be freely excavated by steam shovels.

The work performed by a well drill is due to the action of gravity. The weight of the drill bar and the kinetic energy developed on impact with the rock, by the dropping of this bar from two to three feet, is the limitation of the mechanical work performed. The bar is raised and dropped from 50 to 60 times per minute.

The percussion drill, operated by compressed air or steam, may be obtained of any practicable power or speed and mounted on tripods or carriage, as best adapted to the conditions of the work to be performed. In hard rock, or where holes are required to be drilled at any angle, or under any circumstances where great quantities of material require to be blasted in the shortest time, the high speed percussion drill will demonstrate greater efficiency and economy than any other type.

As a comparative illustration of the useful work performed by a well drill and by a percussion drill in a given time: A well drill with a bar weighing 1200 pounds strikes 50 blows a minute, a percussion drill striking the same blow would strike from 350 to 400 blows in the same time, or, otherwise stated, would perform from seven to eight times the amount of work. In actual practice these results are achieved by percussion drills mounted on carriages and having a vertical feed of ten to twenty feet. These drills are of great power and penetrate the hardest rocks readily. The cost for labor of operatives is about the same per day, but the cost per foot of drilling is reduced proportionately to the comparative performance of either type of drill.

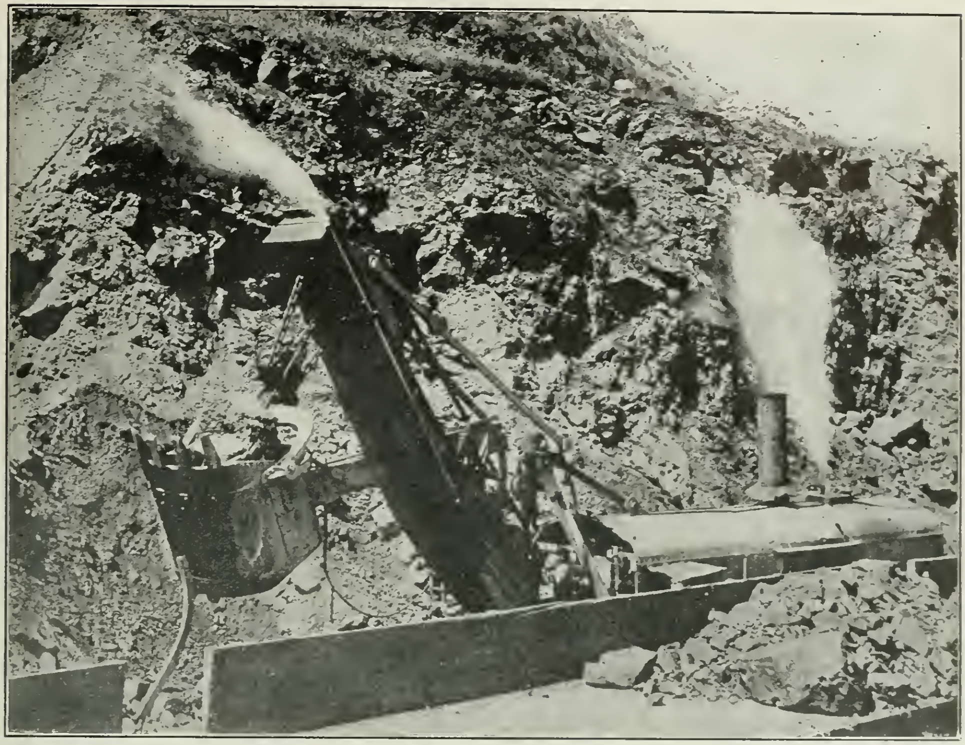
The speed of drilling, or the rate of penetration, is in direct proportion to the area of the hole being drilled, the smaller the hole the less the elapsed time in forming it. To accomplish the most economical result, it is therefore necessary, other conditions being favorable, to drill holes of the smallest practicable diameter and spring the holes previous to loading the main or blasting charge.

SPRINGING AFTER DRILLING.

The process of springing a hole consists in the detonation of a few sticks of high powered dynamite in the bottom of the drilled hole, this forms a chamber or pear-shaped cavity in the bottom of the hole in which to place the main blasting charge. Dynamite confined in this manner in the bottom of the hole, that is, the whole charge placed at that point, is, in its lifting and disruptive effect, more potent as there is not the large drill hole or well to permit the more rapid escape of the volume of gas generated on detonation of the confined explosive. To those not familiar with "springing" it is suggested that some time be allowed to elapse before introducing the main or blasting charge, as the heat generated in springing the hole will make the walls of the chamber hot enough to explode dynamite. Premature explosions due to this cause, and their attendant serious consequences, are not infrequent.

On the Central Division of the Panama Canal, the average number of vertical holes fired each day was 600, averaging 19 feet in depth. An average charge of 24 pounds of explosive was used to each hole. The average number of toe or horizontal holes blasted each day was 100, having an average depth of 15 feet; an average of 30 pounds of explosive was used to each hole. These holes are drilled horizontally into the toe of the bank to secure greater breaking effect of the material above.

Over 30,000 "dobe shots" or "mud caps" were fired in breaking up material ahead of the shovels; this material consisted of the fragments of too large a size for the shovels or cars. An average of about 6¾ pounds of explosive was used to each mud cap, at an average expense, for explosive and blasting, for each shot of 90 cents. One shot was fired to each 450 yards of blasted material excavated, which would make the general cost of



STEAM SHOVEL LOADING CARS. BAS OBISPO CUT.

mud capping throughout the section about one-fifth of a cent per cubic yard of all rock excavated. The average amount of material blasted, over the whole division, to each pound of explosive was 2.21 cubic yards. Saltpeter dynamites of sixty per cent. and of forty-five per cent. nitro-glycerine were used in blasting.

The foregoing recites the essential facts relative to excavation on the Central Division in the mixed materials, ranging from the hardest rock to the loosest and most crumbly formations that would justify the use of explosives in their further disintegration. In addition, there were certain clay formations, which were bored by hand-operated augers and blasted; it was found that the increase of cost entailed in boring and blasting was justified by the consequent increased output of the steam shovels. This was classified as "blasted material," the general term which comprises all materials mined and blasted on this division.

The unit cost of drilling and blasting, on the Central Division during the fiscal year 1912, was $0.1523. The complete operation, comprising drilling, blasting, excavation, transportation and dumping, and all overhead charges was $0.546 per cubic yard, on the dump. From the commencement of the work by the United States until September 1st, 1908, the complete division cost was $0.9344 per cubic yard; from September 1st, 1908, to June 30th, 1912, the cost of all material excavated, about 70,000,000 yards, three-quarters of which was rock, was $0.5127 per cubic yard

COST OF HARD ROCK EXCAVATION.

The cost of drilling, blasting, excavating and transporting of a solid hard rock formation is illustrated in the excavation of a trap formation at Porto Bello. This rock is being used to form and armor the face of the breakwater at Colon. The excavation was developed in two benches of an extreme height of 60 feet. The rock was used in its rough form as blasted.

Loading from the excavation on cars is done by the steam shovels, then unloaded from the cars on to the decks of barges. The costs here given are on the deck of barge, it is considered that this would about correspond, in ordinary work, to the cost on dump or spoil bank. Tripod mounted percussion drills of 3¼ inch piston diameter were used.

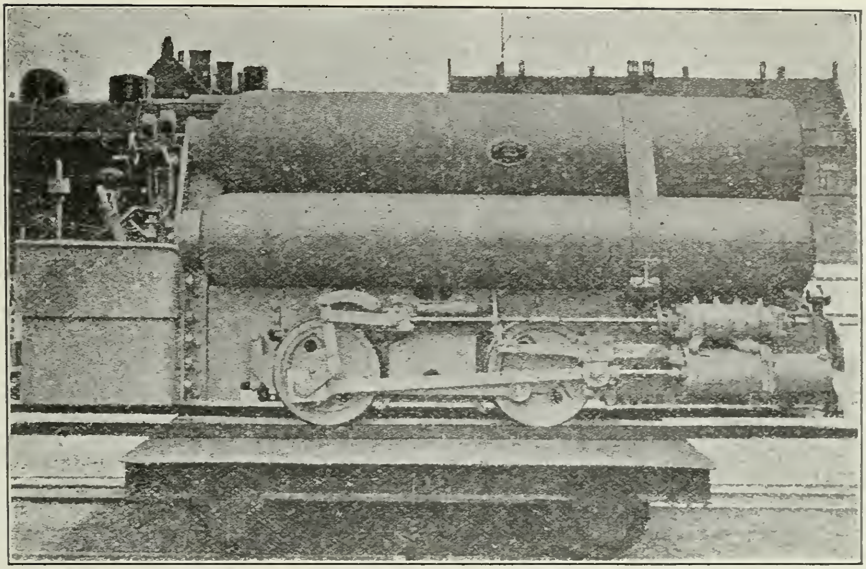
The average monthly cost of stripping, drilling, blasting, loading, transporting, upkeep of tracks, loading on barges, power, maintenance of equipment, and an arbitrary charge for plant, but no overhead or division expense, was $3.25 per cubic yard. These monthly costs varied from the first month at $5.98 per yard to a minimum of $2.16 per yard These costs covered the excavation of 65,132 cubic yards in eleven months. In solid formations, admitting of close classification, the results obtained on the Isthmus would appear to about correspond to results obtained elsewhere under similar management.

The data from which the above report has been compiled are from the reports and statements of the engineers of the Isthmian Canal Commission, from the report of Mr. Donald F. MacDonald, geologist, and from the writer's own experience and from his personal observation of the work at Panama.

HIGH PRESSURE GAS LIGHTING

Discussions we have had with Europeans and Americans recently from abroad teem with expressions of delight at what is transpiring in foreign cities in the way of high pressure lighting. A citizen of this country, long a resident of England and recently on a visit here, told us that he was amazed at the widening development of high pressure lighting in Europe, especially in England, and particularly in London, and marveled that the country which gave birth to high pressure gas was so backward in its application to the lighting problem. "Why," said he, "in London high pressure lighting has thrown a pall over electricity. In some sections of London, owing to unexpired electric contracts, certain thoroughfares continue electric arcs on the one side and on the opposite side high pressure gas lamps have been installed; actually, the gas lamps throw shadows on the area immediately beneath the electrics—what's the matter with our gas friends over here?"

LIDGERWOOD UNLOADER.



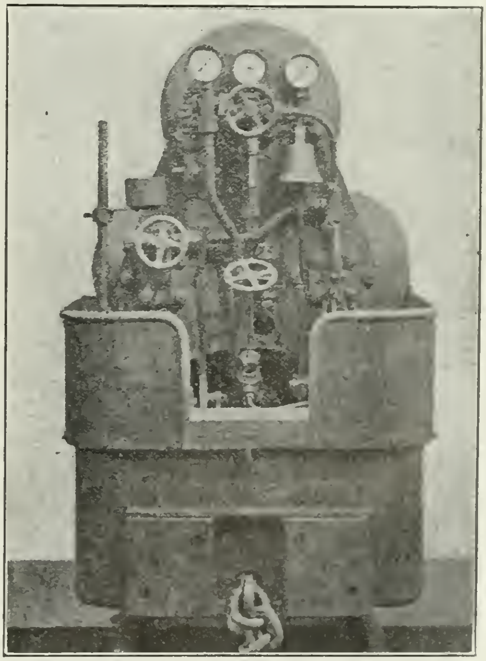
TRIPLE EXPANSION MINE LOCOMOTIVE.

COMPRESSED AIR TRACTION IN BRITISH COAL MINES

The following is a comparatively brief abstract of an interesting article by Axel Sablin in the Iron and Coal Trades Review.

According to this writer the adoption of compressed air traction in British coal mines is quite recent, but the improvements have followed each other with great rapidity, three periods of development being specifically noted. The first compressors, 1907, were designed for about 1500 lb. pressure. The locomotives had single stage cylinders, their tank pressures were about 750 lb. and the working pressure 150 lb. The reducing valve was one of the specially weak points of these machines. Not more than 4000 yards could be traversed with load without recharging and the cost per ton mile was too high to compete with electric traction.

By 1910, which is noted as the beginning of the second period, four-stage compressors worked up to 2250 lb. The pipes conveying the high pressure air were as small as possible, often 1¼ in., steel flasks were inserted in the line for storage and drainage. The locomotives had three or four tanks which would store the air at nearly full delivery pressure, and reliable reducing valves maintained a constant working pressure of 270 lb. The cylinders were compound with an atmospheric reheater between the high and the low pressure. The exhaust from the low pressure cylinders escaped through a nozzle arranged as



END OF LOCOMOTIVE.

an ejector similar to that of the steam locomotive. The remaining energy in the discharged air was thus used to cause a rapid circulation of air in the inter-heater, the low pressure cylinder was prevented from freezing and the admission pressure to the high pressure was thus correspondingly higher than in the older machines. Balanced valves and improved valve gear were adopted, the distance traveled between charges increased to 7000 yards and the air consumption of 1910 was 35 per cent. less than in 1908. Numerous plants were installed and pronounced economically satisfactory, thus encouraging further improvements.

In 1912 another remarkable advance took place. Compressors were built for five stage compression and the delivery pressure was raised to 3000 lb. The locomotives were built with triple expansion engines, using an initial pressure above 400 lb. The high pressure and intermediate cylinders formed a single casting, see Fig. 1. Separate interheaters were arranged between each two cylinders. The traveling distance between chargings, with load, was extended to 10,000 yards. The economy over the locomotive of 1911 was increased by 25 per cent. while the economy of 1908 was improved 55 per cent., so that the air consumption was only 45 per cent. of that of the first locomotives herein mentioned.

These modern locomotives weigh from 5 to 7½ tons; the gage used varies from 16 in. to 20 in., the minimum curve radius is 26 ft. and the maximum economical grade is 4 ft in 1000 ft. The overall length of the standard locomotive is 13 ft. 6 in., but shunting locomotives are built as short as 10 ft. 8 in. The smallest locomotive is 58 in. high and 36 in. wide; the largest 66 in. high and 40 in. wide. On good track, and with a run of not less than one mile, a locomotive has a proved easily maintained capacity of 250 ton-miles per shift of seven hours. The time of recharging the locomotive in the mine is about 1½ minute, a difference of about 300 lb. being left between the pipe line pressure and the pressure in the locomotive tanks.

The air, before being admitted to the compressor, should be filtered through cloth, the suction chamber having a very large filtering surface. The whole system of air pipes is packed with copper rings ⅛ in. thick, rolled from solid discs. Remarkably tight joints are secured by this method; in fact so perfect that in one instance under observation the drop in pressure in the system during the stop from Saturday to Monday amounted to only 150 lb., or about 6 per cent. of the working pressure.

For filling, the tanks of the locomotives are attached to the compressed air system by flexible drawn copper pipes, packed with the usual copper gaskets. Two filling stations are usually arranged: one at the bottom of the shaft, and another at the locomotive "stables." For lubricating, a special oil is used which remains liquid at —60 deg. C. (—76 F.) A train load usually consists of 40 cars, each carrying 1500 lb. of coal or over a ton of rock. On a good track, however, an air locomotive will haul twice this load.

During the last few years there have been put into service in German colleries many hundreds of air locomotives and close on to a hundred air compressor stations. Other plants are found in operation in Austria-Hungary, in Belgium, in France and in Spain.

The continental compressor works are well employed. In one particular shop were seen, in January of the present year, in various stages of construction, 38 air locomotives and 12 compressors, the largest being a five-stage machine with a capacity of 1,750 cu. ft. of free air per min. compressed to 3,750 lb. This compressor was to be driven by a gas engine.

STOPPING A BURNING HIGH PRESSURE GAS MAIN LEAK

The following was contributed by Mr. E. C. Jones, Chief Engineer P. G. & E. Co., San Francisco, in discussion of a paper read before the Pacific Coast Association:

Last September a telephone message came into the office of the Pacific Gas & Electric Co., San Francisco, between 1 and 2 o'clock in the morning stating that there was a high pressure leak in the suburbs of San Francisco. In 20 minutes after the word was received by Mr. Kepplemann he was on the job with a gang of men and found that three holes had been punctured into the 6-in. high pressure line carrying 75 lb. pressure. The gas had been ignited and the flames from the holes extended to a height of probably 25 ft., uniting at the top into one fan-shaped flame, illuminating the entire neighborhood, and the roar of the fire could be heard for blocks. The work was done by miscreants who made use of the substance known as thermit, which has been extensively used for the welding of cast iron and steel. The thermit was placed on top of the main in four places, close together, and ignited, burning holes through the steel pipe, and as the gas issued from the hole it ignited. One of the holes failed to work. Three of them ignited, causing an immense loss of gas, and it seemed when I got on the ground that it was really difficult to put out the fire.

The line which had been tampered with supplies the southern portion of San Francisco with high pressure gas and also all the towns on the peninsula, extending as far south as Palo Alto, and it was impossible at 2 o'clock in the morning to shut the pressure off the line, having on it thousands of consumers with water heaters and pilot lights, bath room lights and all manner of night lights, which it would have been a crime to have extinguished. The question arose, how should we extinguish this flame, because without putting it out it was impossible to stop the flow of gas and to make repairs.

Mr. Kepplemann suggested that in the natural gas fields he had seen means used for extinguishing natural gas leaks. He sent an automobile truck to the city yard and got a length of 6-in. steel tubing 20 feet long, and some rope; he placed the tubing on the ground at right angles to the holes, the holes being three-quarters of an inch in diameter. We reduced the pressure from 75 to 50 lb. on the line, knowing that this pressure would carry with perfect safety. Guy-ropes were fastened near the other end of the 6-in. pipe for the purpose of raising it to a perpendicular position. It was raised by these guy-ropes until it stood directly on top of the 6-in. pressure line and enclosed the leaks.

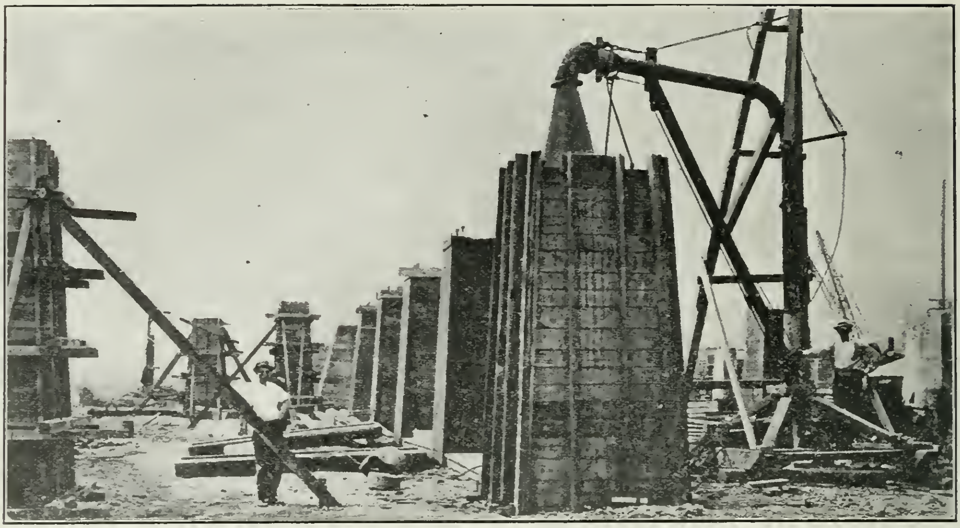
It only took an instant to stop the fire at that point because of the impossibility of the air getting to it. So after the 6-in. pipe dropped on the flame at its smallest point at the bottom, in a second the flame shot from the top of the stand-pipe and the moment it was seen that all of the flame was coming out of the top of the stand-pipe, word was given to let go of the guy-ropes and the pipe was thrown clear of the high pressure line, carrying with it the flame. The gas flame issued from the end of the 6-in. pipe on the ground for half a second or maybe a full second and burned the gas that was in it, but the flame from the high pressure line was extinguished.

We then had some soft pine plugs 4 ft. long prepared and driven into the holes and cut off, and the pipe was bandaged with 3-in. tape, something similar to tire tape, till the gas leak was entirely stopped. The pressure was then raised on the line and no consumers knew that there had been trouble of any kind. In fact, there was no interruption of the service. I mention the fact to show the necessity of having quick means of getting to a job; 20 minutes from the time the police reported this leak, our men were there with automobiles and it took but a few minutes more to go into town and get the length of pipe and the ropes and bring them out on the job. It could not have been accomplished with horses.

I want to call your attention to the necessity for the employment of resourceful men. A man of the calibre of Mr. Kepplemann can save his salary in a very few minutes. I have often been asked how to put out a gas fire on a high pressure main. I believe I have suggested a half a dozen methods and none of them worked, but this simple little thing turned the trick. If you ever have any trouble of that kind simply stand up a pipe and take the flame away. It doesn't matter what the diameter of the stand-pipe is. It may be 6 or 8 or 10 or 12 in. pipe—any pipe that you can handle freely. Be careful not to burn your men. Don't use a coated pipe. Any size pipe will trap the flame and take it away from the leak.

COMPRESSED AIR FOR BUILDING UP MASSES OF CONCRETE

At the Riverside plant of the Otis Steel Co., now under construction in Cleveland, a new method of mixing and placing concrete has been employed which is said to have effected a considerable saving. This method consists of mixing concrete by compressed air in a MacMichael pneumatic mixer and blowing it through an 8-inch pipe from the mixer to the forms. This system has been used in a number of other places. It was formerly used for tunnel lining exclusively, but for such work as the construction of the heavy footings and the high piers for the steel company's plant its economy also has been clearly demonstrated. The work on the Otis Steel Co.'s plant consists of some 40,000 cubic yards of concrete placed in heavy foundations

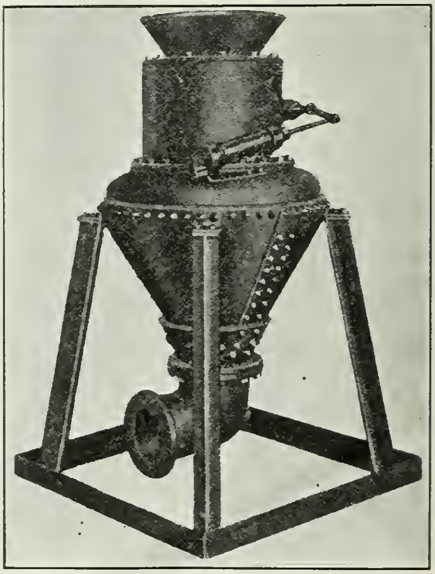


DELIVERING CONCRETE AT A PIER.

and high piers, as shown in Fig. 1. These piers contain from 10 to 19 cubic yards of concrete each. To fill them a goose-neck arrangement was made as shown in the illustrations. This was moved along on rollers between two rows of piers and was so arranged that it would swing to fill four piers each time the pipe line was extended. The pipe line extended 700 or 800 feet from the mixer at the farthest point. During the month of December, 1913, before the work was shut down for the winter, the machine mixed and placed 6,500 yards. This machine was of ¼ yard capacity.

The mixer consists of a conical drum with an elbow at the bottom to which the conveyor pipe is attached, and with a hopper at the top which is closed by a door operated by an air piston. The cement, sand, stone and water are fed into the mixer through the hopper and the door is closed. The air is then turned on, entering the mixer at two points, one above the charge, and one at the heel of the elbow. The 80 pounds pressure which is used mixes the material and blows the mixed concrete through the bottom of the cone and through the pipe to the forms. The output of the machine is dependent upon the speed of loading. The mixers are made in ¼ and ½-yard sizes and the speed of loading varies between 60 and 120 batches per hour. The provision of overhead bins makes possible a higher rate of loading, which would give the ¼-yard machine a capacity of 30 yards per hour, and the ½-yard machine 60 yards. An 8-inch pipe of No. 10 gage metal or an 8-inch well casing is used for conveying the concrete. The facility with which the delivery pipe can be carried under, over or around obstructions which would make wheeling difficult, is one of the important advantages of the system.

The air required to operate the plant varies



THE MIXER.

according to the distance from the mixer to the forms, the number of elbows in the line, etc. A convenient method for estimating the required capacity of the air plant is to assume 1 cubic foot of free air compressed to 80-pound pressure for each lineal foot of pipe per batch of concrete. For general concreting work a compressor of 600 cubic feet per minute capacity is probably the best size, although a 300-cubic foot machine would be large enough to use with a ¼-yard mixer and 300 feet of pipe.

Clogging of the pipe may occur when stones of too large size are used. It has been found that the limit in size for successful operation is about 2 inches. Where crusher-run stone is used with this machine, as it has been on three jobs, a large rock occasionally gets in an elbow and plugs it. In some cases this can be loosened by tapping the pipe while the pressure is on, but if the rock is too large or too tightly wedged it is necessary to remove the pipe and punch out the obstruction. No clogging occurs, however, when the proper size of stone is used, providing the machine is not operated with an air pressure very much below 80 pounds. An air storage tank is usually placed close to the machine, the capacity of this tank being large enough to store sufficient air at 80 pounds pressure to discharge one load, which means 1 cubic foot of space for each 6 feet of pipe line.

SIZE OF PIERS.

The Otis Steel Co. used a ¼-yard machine at Cleveland for placing the piers for its new plant. The piers range in height from 12 to 18 feet above the ground, and each contains from 10 to 19 yards of concrete.

The machine is located under bins which are kept filled by clam shell buckets operated by locomotive cranes, the distribution pipe having a total length of 750 feet. The air is furnished by an Ingersoll-Rand motor driven compressor of 600 feet per minute capacity, and the plant is operated by eight men.—*Iron Trade Review.*

Vertical depths of shafts at the Calumet & Hecla copper mine, Michigan, are as follows:

	Feet.
Red Jacket	4900
No. 5 Tamarack	5308½
No. 3 Tamarack	5253

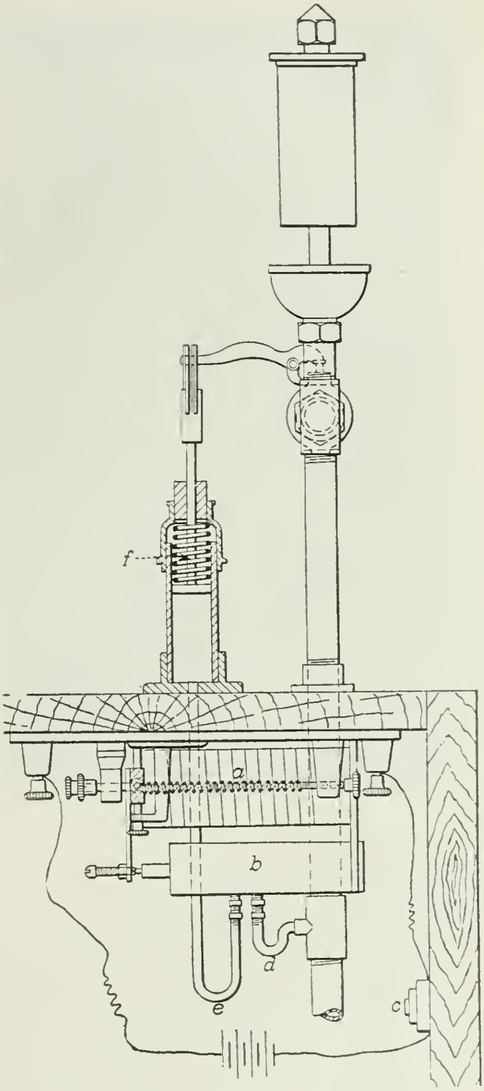


FIG. 1.

A COMPRESSED AIR FACTORY CALL WHISTLE

For calling foremen, superintendents and others who frequently have occasion to leave their posts to go to different parts of a manufacturing establishment, the Newton Machine Tool Works, Inc., Philadelphia, Pa., has developed a compressed air call whistle controlled by an electric push button. Instead, however, of a 110 or 220 volt electric circuit, the whistle is operated from four dry batteries.

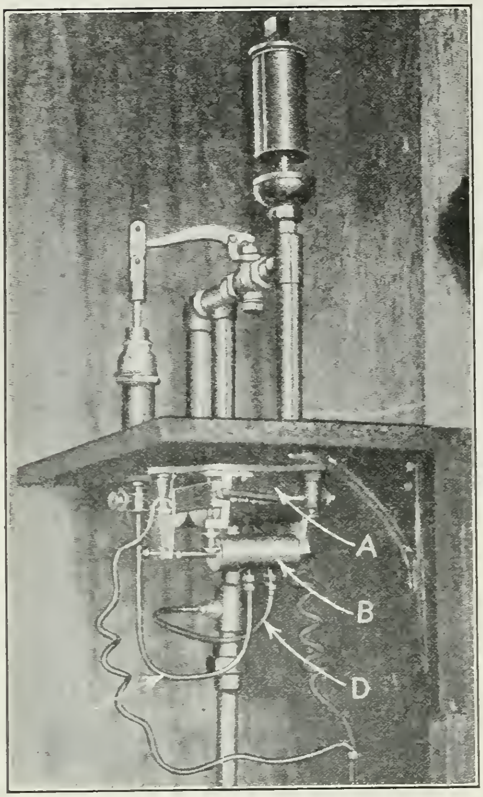
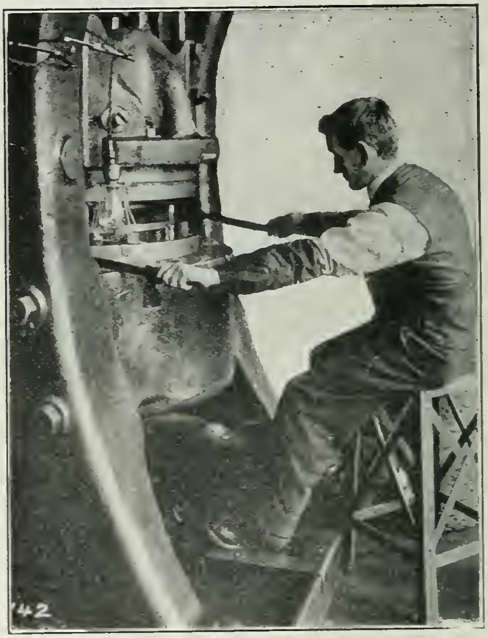


FIG. 2.

When this device, known as the Marx-Heisler call whistle, is installed in a factory, the push button may be mounted alongside of the telephone operator. The two principal parts of the device are a magnet, *A, a,* and the valve *B, b.* When the button *c* is pressed the circuit is closed through the battery and the magnet and the armature of the latter is attracted toward the pole piece. Attached to the armature is a downwardly projecting extension, which, when the magnet is energized is brought in contact with the projecting stem of the valve *B, b.* This stem is pushed in so that air flows into the valve through the pipe through the pipe *E, e,* the air compressing the *D, d* from the compressed air line and out spring *f* and permitting the whistle to operate. As soon as the pressure on the button is released the armature of the magnet flies back and the air which is flowing into the valve through the pipe *D, d* forces the stem back and cuts off the entrance to the pipe *E, e.* An exhaust port is provided for the valve to permit the spring to force out the air when the pressure is removed.—*Iron Age.*

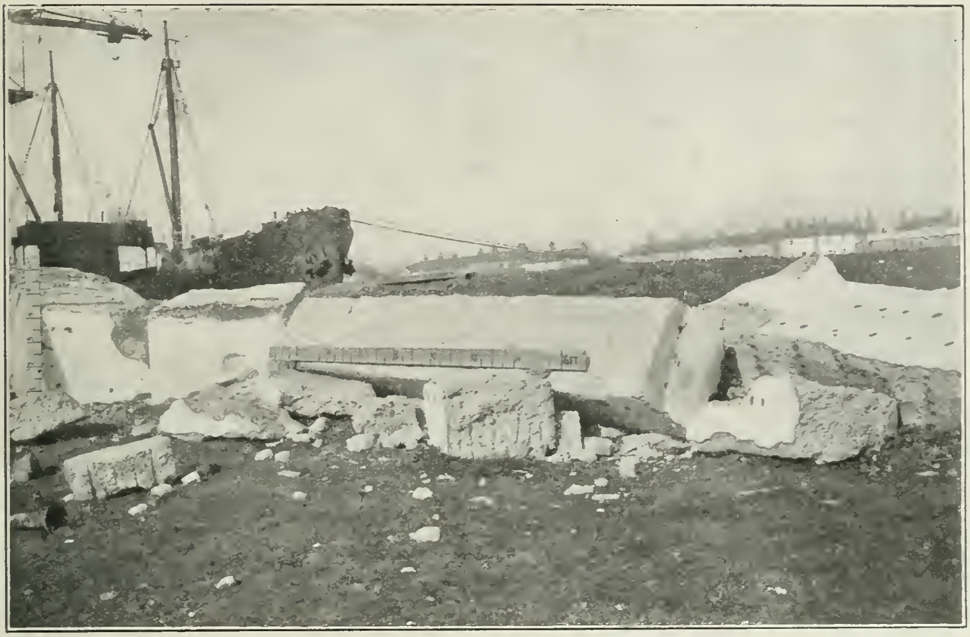


SAFETY VACUUM DEVICES FOR PUNCH PRESSES

For a considerable time the Westinghouse Electric and Manufacturing Company, at its shops at East Pittsburgh has been experimenting with mechanical devices for the safety of the operators in the punch shop, and after many discouragements practical success has been attained.

Before the adoption of the arrangement here illustrated a man was placed at the back of the press to feed in the sheets, and he was the man who most frequently was injured, because his fingers were entirely at the mercy of the operator in front. The vacuum lifting device enables the operator of a punch press in the first place to dispense with the helper, and at the same time all danger to the hands is removed.

It is an exceedingly simple affair, consisting of a "sucker" or lifter about 8 in. diameter which is connected by a rubber hose to a suction line running through the shop, and moves freely back and forth upon an irregularly shaped rod, its travel being controlled by the press operator by two guide arms or handles,



MONOLITHS CUT OUT BY JACKHAMERS.

one on each side of the punch and die and just inside the press housings.

A pile of metal sheets being placed in rear of the press preparatory to being punched, the operator in front pushes the guide arms through the press toward the pile. The irregularly shaped rod allows the sucker to drop until it rests upon the top sheet of the pile when a lever on one of the two guide arms is pressed, thus opening the vacuum valve and causing the sucker to grip the sheet. The guide arms and the suction lever are not released until the first blank has been punched. By thus retaining hold of the guide arms practically all danger of injury to the hands is removed, for in punching the succeeding blanks from the sheet it can almost invariably be pulled forward by means of the scrap or margin.

Since the adoption of the suction device there has not been an amputation on the large presses, and up to the present time no finger has been cut off in the punch shop.

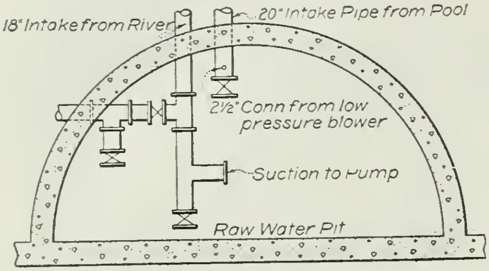
The device was exhibited and received a grand prize at the recent International Exhibition of Safety and Sanitation, and it is now on exhibition in the American Museum of Safety, New York.

JACKHAMERS BREAK UP CONCRETE FOUNDATIONS

At the Brighton (Eng.) Corporation Electric Works there were some heavy concrete engine foundations to be removed and the half tone on this page tells the story. The concrete was exceptionally hard, made of clean small beach, cement and gravel, and there was enough of the work to be done to make it worth while to arrange to do it economically and expeditiously. The engineer hired a 7 by 6 in. NE, Ingersoll-Rand compressor, and he was able also to borrow a couple of Jackhamer drills. The outcome of the job was so satisfactory that he finally bought the compressor and also another Jackhamer drill to be kept for another similar job in the near future.

The concrete was removed in large monoliths, some of them weighing 20 tons, split off from the mass by what is familiarly known in quarry work as the "plug and feather" method. A string of holes was drilled all around the monolith and the plugs were driven by a 2½ ton battering ram suspended from the big engine room crane. The block shown in the middle of the picture has been run out of the engine house upon rollers, by means of a winch and wire rope.

The ordinary style of chisel bits were used, 20 in. long, and they were run in as far as they would go, say 18 in. The holes were spaced about 9 in. apart, and the average drilling was 7 holes an hour.



COMPRESSED AIR TO REMOVE ANCHOR ICE

At the Moline, Ill., Water works the water comes to the plant through two intake pipes, a 20-in. 350 ft. long and an 18-in. pipe 3,500 ft. long. The water flows by gravity to a well and is then pumped to the filter plant. The intake pipe with this air attachment extends something like 350 ft. into the river. It is open and unprotected at its mouth; no crib or other device has been built about the pipe.

Formerly a centrifugal pump was so arranged that it could be connected to the 18-in. line, and in an emergency the water could be drawn through this line until the well was filled, and then the valve on the choked 20-in. line was opened, letting the full pressure bear against the obstruction. The depth of the well is about 20 ft., and the head usually obtained by this means is but 15 ft. This system, while helpful at times, could not be relied upon, for as long as the 18-in. line remained open things were satisfactory, but just as soon as the ice began to choke, the plant was at a standstill.

During the past year the chief engineer, Mr. Buck, has attempted to improve the plan by connecting the blower used to air wash the filters to the 20-in. line. The blower used is of the Root make, giving a large volume of air under low pressure; that is, up to about 10 lbs. At times for very short periods the pressure has been forced up to 30 lbs. The connection between the blower and the line is through a 2½-in. pipe connected to the intake pipe, near the raw water well end.

On nights when the temperature conditions indicate a slight freezing, the height of the water in the raw water well is carefully watched. When the level begins to drop, the blower is started and in a very short time the line is completely cleared. At times when the line has been choked tight, the blower has without fail cleared the line in a few minutes. The maximum pressure needed or used for this purpose runs about 10 lbs. per square inch. From the accompanying diagram the layout of the raw water well and the air connection can be clearly understood.

The Mississippi River water, turbid and colored, seems to be affected in no way in the formation of anchor ice, other than the temperature. It is claimed by some that the appearance of this ice occurs only on certain nights—nights following clear days, or a clear night, not cloudy ones, etc. Clear days and cloudy days alike seem to have little influence over the ice problem in the Mississippi River so far as we have been able to observe. The main trouble usually becomes noticeable after midnight and remains until the appearance of daybreak.

The above information is taken from a paper by Mr. L. A. Fritze, chemist of the Moline water department, before the Illinois Water Supply Association.

STRUGGLE BETWEEN LIGHT AND HEAVY WATER

A difference in water density at the lower ends of the Miraflores and Gatun locks at Panama has, according to the "Canal Record," developed a current of probably 3 or 4 miles per hour under certain conditions. At the stage of a downward lockage when the surface of water in the lower chamber has been brought down to evenness with that in the approach the water within the chamber is more than half fresh. It has, in consequence, less density than the sea water beyond the lower gates, and when the gates are opened the heavier water thrusts its way inward against the lighter, causing a current opposed to the outward passage of a vessel. The current being temporary, causes no serious inconvenience, and is being studied principally to determine accurately the conditions for the manipulation of the towing locomotives.

A tunnel under the Danube is planned by the Roumanian Government to form a connection with its newly acquired territory.

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ALFRED NOBLE

At three score years and ten a useful life
Has run its course. And as we think of him
The sorrow and the flowing tears of friends
Are turned to joy that such a one as he
Has lived and wrought. He was a man who led
In building up, his mind endowed to see
And think and do in all the larger things,
A Captain leading men on Nature's fields
To win in building monuments of peace.
This Engineer has shattered Nature's works
To make the world a better dwelling place
For all of us. His life was gentle and
No thought of self within him dwelt. He won,
Scarce knowing why, the plaudits of the world.
Above his resting place let it be writ:
He was an Engineer. He was a Man.

W. L. S.

COMPRESSED AIR TRACTION IN COAL MINES

On preceding pages of our present issue we have an interesting, authoritative account of the recent developments in and the present status of compressed air locomotive traction in British, or, more correctly, in Continental coal mines. Perhaps the most astonishing thing about it is the rapidity with which the improved practice has developed and the large increase of economy attained. Within seven years, we are told, the power cost of compressed air mine traction has been reduced more than one-half, while the service has been improved in various other ways, so that it is no wonder that the builders of the special locomotives required and of the compressors required for charging them have their hands full. The leading and most successful practice, it appears, is not in British mines, but in Continental Europe, where from our mistaken and too fixed habits of thought we would have least expected it.

Those who are now reporting these successes may be said to have begun where we left off, when there should have been no such "leaving off," no acceptance of things as they were. The mistake in British, and perhaps more pronouncedly in American practice has been in not following up the opportunities for improvement which would have been easily discoverable if properly looked for. In too many coal mines where compressed air traction is now accepted as more or less of a necessity single stage locomotives are still in use. Conpound locomotives are now in many cases replacing them, and these are giving good account of themselves, but the day of the triple expansion locomotive seems not yet to have arrived.

SUCCESS OF HIGH PRESSURE ILLUMINATING GAS

The following we take from a valuable paper by Mr. F. Victor Westermaier, of Philadelphia, before the Illinois Gas Association at Chicago, March 18.

Without reference to the highest type of lighting made possible with gas raised to two and three pounds pressure per square inch, the subject of gas street lighting would be incomplete. The advantages of high pressure gas lighting have been so evident where high candle power units and greater efficiency are required, that numerous cities abroad have adopted it as the principal illuminant for street lighting. With units of 1,000 to 4,500 candle power, operating at efficiencies of 45 to 60 candles per cu. ft. of gas consumed, not only is the standard of street lighting raised, but is given a formidable position as the highest powered illuminant. Notwithstanding the large investment required for special mains, compressor plants, new lamps and posts, Berlin, London and Paris are continually extending high pressure gas street lighting. These extensions are being made solely on merit and in sharp competition with the most modern electric units.

In Berlin one finds the greatest systematic municipal developments along modern lines, therefore its adoption of high pressure gas street lighting, to the extent of sixty miles of principal streets, should serve as a stimulus to the entire gas lighting industry. While, it owns the principal gas plants within its limits, it also has in a way control of the electric light plants, in that the city will acquire them in tht near future. There is no indication that the fact of ownership gave gas street lighting in Berlin any advantage over electric lighting. Not until extensive, careful, experiments had been carried out in the most systematic manner, was gas finally adopted, it having demonstrated conclusively its absolute reliability and fitness for delivering the high degree of illumination required, at a lower cost than could have been obtained with electricity. The influence of Berlin's adoption of high pressure gas lighting has spread to many European capitals.

In view of the development of high pressure distribution systems in America, it is remarkable that the advantages of high pressure lighting have not been recognized and advanced. The installations made so far have been mostly of an ornamental nature, for lighting the exteriors of gas office buildings. There are, however, two street lighting installations which have been in operation for a sufficient length of time to demonstrate the practical advantages of introducing large candle power units where high pressure gas is available. One of these is at Atlantic Highlands, N. J., where fourteen 500-candle power units, were installed early in 1913. After a year's operation the service rendered has been so satisfactory that the number of lamps has been doubled with the prospect in view of a further extension of high pressure lighting throughout that entire district.

The other street lighting installation is at Waterbury, Conn., for lighting the approaches to the Railway Station. The fact of there being a high pressure feeder line nearby, enabled the gas company to install seven 500-candle power lamps. These units have given very satisfactory service for over three years, and had it been practical to extend high pressure mains in other parts of the city, additional gas street lighting could have been obtained. The polar curve of the lamps at Waterbury and Atlantic Highlands shows that for street lighting purposes the distribution of light in the vertical plane from an inverted mantle is much better with high pressure than with low pressure gas.

Probably the finest example of street lighting in the United States was shown in Philadelphia during the convention of the National Commercial Gas Association in December, 1913. Thirty-six lamps were mounted on both sides of Broad street, between Walnut and Spruce streets, high pressure gas being supplied through a line of 3-in. main temporarily laid on each side of the street and connected with a booster plant in the convention hall. Each lamp was equipped with a mercury seal distance lighter, located in the base of the post, which opened the gas valves to the burners when the pressure in the main was raised to the required three pounds per square inch; closing them, and opening the pilot supply when the pressure was reduced to normal.

SAFETY FIRST IN SHAFT SINKING AND TUNNEL CONSTRUCTION

BY WALTER I. SWEET.*

A great deal has been said about the Catskill Aqueduct as an unparalleled achievement in engineering, but very little has been said or written about the appalling cost in human life, and the maimed bodies of those who have been engaged in making this aqueduct a reality. There have been in the neighborhood of 300 lives lost, and more than 6,000 persons have been seriously injured The builders maintain that the toll is one that must be expected in an engineering task of such a magnitude.

In the opinion of one who has made a minute study of the causes of most of the casualties, more than 50 per cent. of the accidents could have been avoided if the proper precautions had been taken. One day a man is killed by a premature explosion, and the next another is crushed to death by a falling rock from the roof of the tunnel, or from the walls of a shaft, and so it goes on.

SHAFT SINKING AND TUNNEL CONSTRUCTION.

Shaft sinking and tunnel construction were two of the most hazardous occupations that were engaged in while constructing the Catskill Aqueduct. It has not always been the builders who have been to blame for the numerous casualties that have occurred. A great many of the accidents have been directly due to the carelessness of the miners themselves. Another cause for a great many of the accidents can be put up to the superintendents in charge of the different shafts and tunnels, as there is considerable rivalry shown between these men, one trying to drive a few feet more of tunnel or shaft than the superintendent in the adjoining shaft or tunnel. It is necessary to keep hounding the drillers and muckers, and the continual speeding up methods caused the men in charge of the work to set aside due caution. This generally resulted in serious accidents. While a very few of the builders go into the tunnels, they always instruct their superintendents to prevent accidents at any cost. Accidents in this class of work can be reduced when men engaged in directing the operations become educated to the fact that one accident will cause more delay than a few hours spent in installing proper safeguards.

It has always been a hard problem for the builders of shafts to install any means for guarding the muckers and drillers engaged on this class of work. It is only practicable to concrete a shaft 50 feet from the bottom, for if the timber or concrete was extended to a greater depth it would be injured by the blasting operations. The muckers and drillers are constantly exposed to falling material, buckets and rock both from the walls of the shaft and from the surface. It is necessary to use the utmost precaution when operating buckets over the heads of the workmen in the shaft.

Safety hooks should always be provided and the cables and engines should be periodically inspected by competent men. A number of accidents on this class of work have been due to the carelessness of the engineer in charge of the hoisting engine. The engineer lost control of the engine, which resulted in the dropping of the bucket containing a number of men onto the drillers in the bottom of the shaft. These mishaps caused the death of a number of men. Casualties of this kind can only be avoided by installing engines with an automatic brake. The type of brakes now in use necessitates the engineer holding his foot on a treadle, and if anything occurs to the engineer the engine is bound to race.

In sinking the river tunnel of the Catskill Aqueduct it was necessary to devise some means to protect the men in the shafts from shooting rocks. A form of steel support was therefore designed by the engineer on the ground to meet this condition. It consisted of 8-in. 13¾-lb. channel ribs, or rings, spaced 4 feet 6 inches on centers, and lagged with ⅜-inch plates, 25x48 inches, curved to the radius of the rings. The plates were bolted to the outside of the channels which were bent web out. The ribs were formed by four quadrants bolted with the curbed fish plates. They were placed by hanging them from the next higher ring by means of long bolts with pipe separators. Every third to sixth ring was further supported by resting it on steel dowels driven into holes drilled in the rock walls of the shaft. It was practicable to keep this steel support within 15 feet of the

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*Safety Inspector for the General Accident, Fire and Life Assurance Corporation. Abstract from *Safety Engineering*.

shaft bottom. With this extra precaution the accidents which were caused by shooting rocks were decreased considerably. One of the contractors engaged on this work devised a heavy wire screen guard which was supported by angle iron. This guard was suspended over the muckers and drillers to prevent them from being injured by any falling rock or material. This screen guard was abolished after a short duration of service. Owing to the irregular shape of the shafts it was necessary to make considerable changes in the shape of the screen as the work progressed. One precaution that can be taken is careful and frequent scaling of the walls of the shaft. It is necessary to stop the work of drilling and mucking while the scaling is being done, and on this account the work is very seldom done thoroughly. Scaling is work that is very tedious and it is also very hazardous, and unless this work is looked after by competent men there are bound to be a great many accidents due to falling rocks. After the shafts have been sunk to the required depth, the frames and guides for the cages are installed, and after this work is completed the hasardous work in connection with shaft sinking ceases.

Gates are provided for guarding the cages. They are not automatic, but are raised and lowered by a signal man whose duty it is to work these gates and signal the engineer when to start or stop the cage. There is a steel roof on the cage to protect men riding on the lift from being injured by falling material or rock. Each cage is equipped with safeties which hold the cage firmly to the guides in case the hoisting cables break or become slack. The hoisting engines are equipped with overwinding devices which automatically stop the cage at the limit of travel, both at the top and bottom of the shaft.

The safeties on the cages are inspected periodically by cutting the cables and allowing the cage to drop, this being the only proper means for testing this type of safety. Accidents due to the falling of a cage have been very rare. No gates are installed at the bottom of the shaft as they would be more liable to cause an accident than to prevent one. A few fatal accidents have been caused by employes being killed due to the operation of the cages. One of these accidents was caused by an employe reaching into the pit to get water just as a cage was descending, and the man was killed by the cage. No matter what sort of a guard had been installed it would not have prevented an accident of this kind. A great number of the accidents that occur in shaft sinking can be avoided if a few safeguards are installed, and if the men engaged in this class of work will use precautions.

TUNNEL CONSTRUCTION.

Tunnel work cannot be compared with shaft sinking from a hazardous standpoint, as the miners are not subjected to the constant hoisting of material and buckets over their heads. Accidents in tunnel work can be prevented by installing the proper safeguards, and educating the men themselves not to take chances and how to avoid accidents. A few safeguards that are practicable to use on this class of work will be seen in pictures in different parts of this article.

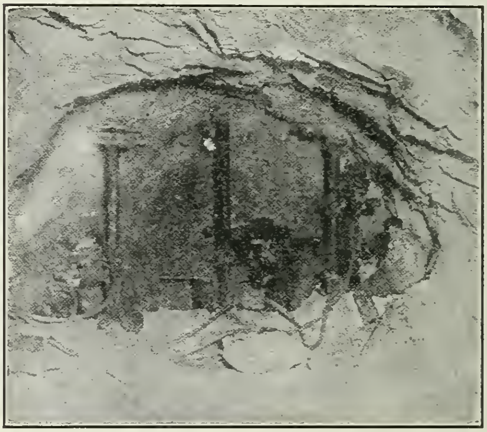


FIG I

Fig. 1 shows a view in the heading of a tunnel. The columns shown distinctly are used to hold the drilling machines in position, and the same columns to some extent are safeguards, as they support the roof. The serious accidents in the headings occur from rock falling from the roof and walls of the tunnels. These accidents may be prevented by proper scaling. Premature explosions have caused an appalling toll of death. There have also been a number of accidents which have been caused by the muckers' picks and shovels striking an unexploded stick of dynamite, but the two last named causes for accidents are gradu-

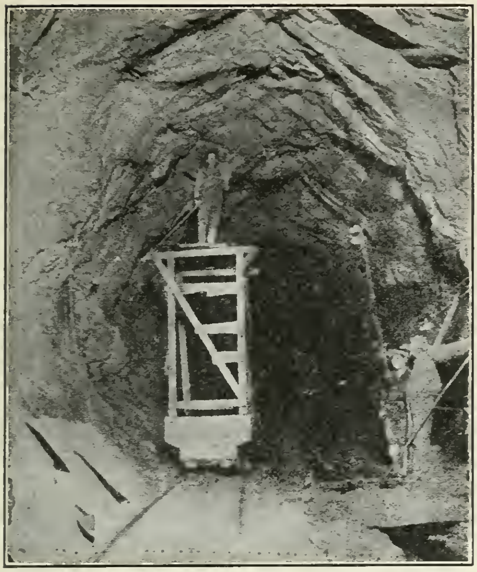


FIG. 2.

ally being obliterated. Fig. 2 will show how effective scaling can be done.

While making an inspection of a certain tunnel the writer had occasion to witness a fall of rock from the roof that was 65 ft. long, and about 6 ft. in diameter. This fall caused the death of one man. It was miraculous that no other casualty occurred, for if this fall had occurred during the changing of a shift the loss of life would have been appalling. The proper scaling of the roof of this tunnel would have detected this loose rock and the accident would have been avoided.

The mucking is done by a very poor class of men, and, as the work is not very desirable, there is a constant changing of the men, so that a gang of unskilled laborers is on this work all the time. This condition also is the cause of the numerous accidents that occur on this work, for as soon as the men get so that they can wheel the barrow over the planks without falling they give the job up for some more desirable work. The platforms used for mucking need constant inspecting, for the men who set them up do not secure them properly. Insufficient light is another cause of a great many of the accidents, as in most cases very poor light is provided on the benches and in the headings.

The concreting of a tunnel is also a hazardous class of work. The moving of the heavy forms in congested quarters caused a great many crushed hands and feet, but most of these accidents are unavoidable. A more skilled class of men are employed in concreting and the only safeguard is for the men to use precaution.

The electric locomotives which are used for conveying material in the tunnels have been the cause of a great many accidents that could have been avoided. A poor class of men is employed to operate these locomotives, this condition being the direct cause for most of the accidents that have been due to the operations of the trains. The employes have orders not to ride on the trains, but this order is not obeyed. Some of the most serious accidents that have been caused by the trains are—no means of signaling, no taillights on the trains, poorly constructed track, low timbers from the forms, and from running the trains too fast.

The electric hazard in the tunnel has also been the cause of a great many serious accidents. The tunnels for the greater part are extremely wet and 500 volts are carried on the wires used to drive the locomotives. This wire is low and within easy reach of the men riding on the trains, and the employes engaged in placing the concrete forms work continually about this wire.

While considering "Safety First" in the tunnels and shafts, the safeguarding of the equipment on the surface and in the tunnel should not be overlooked. While it may not always be practicable to safequard tunnelmen and shaft sinkers, it is practicable to safeguard all the machinery used in connection with this work. Some of the machinery that has caused a number of avoidable accidents are concrete mixers, crushers, screeners, conveyors, hoisting engines, derricks, tramways, steam shovels and power plants.

A great deal more can be said in connection with installing safeguards on work of this nature, but the writer has only attempted to set forth the most hazardous parts of the work, and to mention a few practical means of safeguarding the workmen. Every means towards preventing accidents that has been mentioned in this article is practical and is in use along the whole distance covered by the Catskill Aqueduct. The use of such guards will reduce accidents 80 per cent. The guards mentioned in this article can be used on all classes of contracting work. To get good results towards preventing accidents on all engineering work, the work should be inspected by competent inspectors. While contractors and engineers engaged in construction work wish to reduce accidents to a minimum, they have not the time to spare to give this branch of the work proper attention.

I wish to acknowledge the courtesy of my chief engineer, Mr. C. S. Whitney, for permission to use the pictures and data from the files of the corporation.

NEW BOOK

Compressed Air. A treatise on the production, transmission and use of compressed air. By Theodore Symons. New York, McGraw-Hill Book Company. XII+173 pages 6x9 in. 42 cuts, appendix of tables. Price $1.50.

This book serves up the familiar data relating to the compression and transmission of air with somewhat more than the usual mathematical trimming, and it should appeal to the faculties of freshwater colleges as an ideal text book. We cannot recommend it to the practical man, because it is so far from covering the now extensive field of compressed air practice, and such a man after going through it would want to know just what he wanted to know before. Typograpically the book is one to be proud of.

NOTES

J. Spencer Smith, William L. Saunders and Richard C. Jenkinson, who constituted the old New Jersey Harbor Commission created in 1911, have been named as three of the five members of the newly created permanent commission. Their terms of office will be respectively five, four and three years from April 1. The other two nominees, whose terms will be respectively two years and one year, are W. Parker Runyon and Charles S. Boyer.

"The Ingersoll-Rand Company announces the opening of a new branch office and warehouse in the city of Los Angeles, California, 1036 Union Oil Bldg. This branch will be in charge of Mr. W. A. Townsend, formerly Manager of the Company's El Paso office. Mr. J. D. Foster succeeds Mr. Townsend as Manager of the El Paso office. Also the opening of a branch in the city of Juneau, Alaska, under the immediate charge of Mr. Frank Carroll. Mr. Walter A. Johnson, formerly of Atlanta, Ga., has been appointed Pneumatic Tool Manager of the Pittsburgh Branch of the Ingersoll-Rand Co. and Mr. C. F. Overly, formerly of Pittsburgh, Pneumatic Tool Manager of the Company's Cleveland Branch."

One of the Panama Canal locks at Gatum has been used as a drydock for overhauling five submarines. As the locks are in pairs this can be done without interfering with the passage of vessels through the other side.

A new system of signaling has been instituted at the Windsor colliery, in South Wales. They are endeavoring to abolish all electric signaling, and have devised a scheme of signaling with blast hooters, which have been put on every main-haulage engine on the east side of the colliery. The hooters are attached to a compressed-air column, and this is said to operate successfully. The pulling of a wire which runs along the roadway gives the signal to the engineman.

Under the old method of ventilating the tunnels of the London Underground Railways the air was withdrawn by means of an exhaust fan. By the device now being installed at the Edgware-road, Euston, and at the new Embankment Station, unlimited supplies of air will be pumped into the tunnels throughout the day and night. Ordinary air is passed through a washing screen which extracts all impurities, the requisite humidity is next imparted, a proportion of ozone is added, and it is then sent into the stations at the rate of 25,000 cubic feet per minute.

In the recently enacted law of the State of New Jersey for the regulation of work in compressed air it is required that employers carrying on compressed air work shall employ one or more licensed physicians; if the maximum air pressure exceeds 17 lbs. they also must employ one or more registered nurses to act in case of accident or illness from the compressed air. The bill provides that every tunnel, caisson, compartment or other place where compressed air is used and to which the act applies shall be so constructed, equipped and operated as to provide proper protection to the persons employed. One provision is that no person known to be addicted to the excessive use of intoxicants shall be permitted to work in compressed air.

An extraordinary fatal accident occurred at the Morning mine in the Coeur d' Alenes, as noted by state mine inspector, Robert N. Bell, in his report for 1913. One J. R. Jones was hammering an ore chute that was hung up two floors above. It is customary to cut vent holes in these chutes at every floor but the vents at this point had got choked with muck. When the heavy mass of wet ore let go, therefore, it acted as a great piston, compressing the air below it in the chute and blowing off a plank. The plank struck the man hammering the chute and crushed his head against the ladder, killing him.

A rope railway, 75 miles in length, is to be put into operation in India. It will connect the rich country in the vale of Kashmir with the plains of the Punjab over the Himalayas. The line, it is claimed, will be the longest in the world, the present longest being 22 miles and situated in Argentina. Sections will be 5 miles long, and most of the spans will be 2400 ft. The steel towers, some of which will be 100 ft. high, will be braced, and double 1½ in. cables, 9 ft. apart, will carry the steel cars. The carrying capacity of these cars will be about 400 lb.

A means of obtaining extra high temperatures from an electric arc is described in the *Electrician.* The method consists of combining with an ordinary electric arc a jet of air or oxygen or an oxy-acetylene or oxy-hydrogen flame. The simplest form of the apparatus has a hollow carbon electrode through which a blast of oxygen or air can be blown. The metal plate to be heated forms the positive pole and the carbon electrode the negative. The arc is struck in the ordinary way and operated by a special mechanism with a hand feed. Several other arrangements may be used, some of which have separate pipes serving to project the oxy-acetylene or oxy-hydrogen flame on to the electric arc. It is stated that the effect of the oxygen burning inside the arc is to produce a temperature greatly in excess of that of the electric arc alone; also a similar effect is obtained when the oxy-acetylene or oxy-hydrogen flame burns in the same space as the electric arc.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 7.

1,092,141. ELECTROPNEUMATIC BRAKE APPARATUS. Edward H. Dewson, New York, and Walter V. Turner, Edgewood, Pa.

1,092,237. PNEUMATIC ROCK-DRILL. Thomas J. Barbre, Denver, Colo.

1,092,268. LOCOMOTIVE SAND-BOX. Harry Idoine, Altoona, Pa.

1,092,278. COMPRESSOR. Edwin M. Mackie, North Tarrytown, N. Y.

1. In combination with an air compressor, fluid pressure actuated mechanism, a valve controlled thereby and co-operating with the compressor and arranged when operated to cause the compressor to work without compression, valve mechanism for admitting and releasing compressed air to and from said fluid pressure actuated mechanism, and comprising independent admission and release valves, and a governor proper controlled by the speed of the compressor and having two plungers movable in unison in accordance with the speed of the compressor and arranged to operate said valves respectively.

1,092,302. PULVERIZING OR GRINDING MACHINE. Edward J. Steckle, El Paso, Tex.

1. The combination with a pulverizing mill having means for exhausting air together with fine material from the pulverizing chamber above the pulverizing elements and for returning the air freed from the fine material to the pulverizing chamber of the mill above the pulverizing elements, of means below the pulverizing elements for the escape by gravity of pulverized material from the mill, and means for directing the fine material extracted from the air exhausted from the mill to the material escaping by gravity from the mill.

1,092,339. DEVICE FOR ACCELERATING THE APPLICATION OF PNEUMATIC BRAKES. Francois Jules Chapsal and Alfred Louis Emile Saillot, Paris, France.

1,092,396. AIR AND GAS COMPRESSOR. Michael Riesner, Cincinnati, Ohio.

1,092,495. AIR-PUMP. Carl E. L. Lipman, Beloit, Wis.

1,092,641. AIR-TANK. Ward V. Garceau, Grand Rapids, Mich.

1,092,680. TRACK-SANDER. John H. Watters, Augusta, Ga.

1,092,718. TRAIN-STOPPING APPARATUS. Arnold O. Johnson, Elnora, Ind.

1,092,782. GAS-COMPRESSOR VALVE MECHANISM. Casper W. Miles, Anderson township, Hamilton county, Ohio.

1,092,804. PNEUMATIC DUST - REMOVER FOR CARDING-ENGINES. Joseph J. Smith, New York, N. Y.

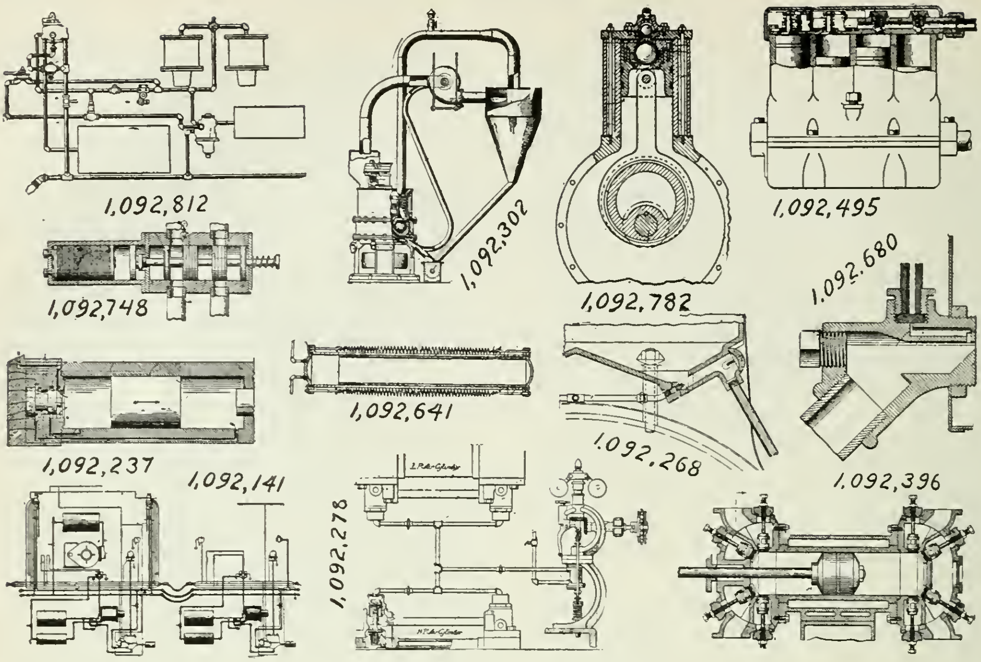
1,092,812. AIR-BRAKE SYSTEM. Frank H. Dukesmith, Meadville, Pa.

APRIL 14.

1,092,852. FURNACE AND AIR-INJECTING NOZZLE THEREFOR. John H. Parsons, Philadelphia, Pa.

1,092,873. IMPULSE-PUMP. William H. Stuttz, Toledo, Ohio.

1. The combination of a cylinder, a floating pump piston movable in the cylinder, means for permitting air to pass in but one direction to the compression side of the pumping piston, means for pneumatically operating the piston, and an engaging means for holding the said piston at one end of its stroke until the pressure

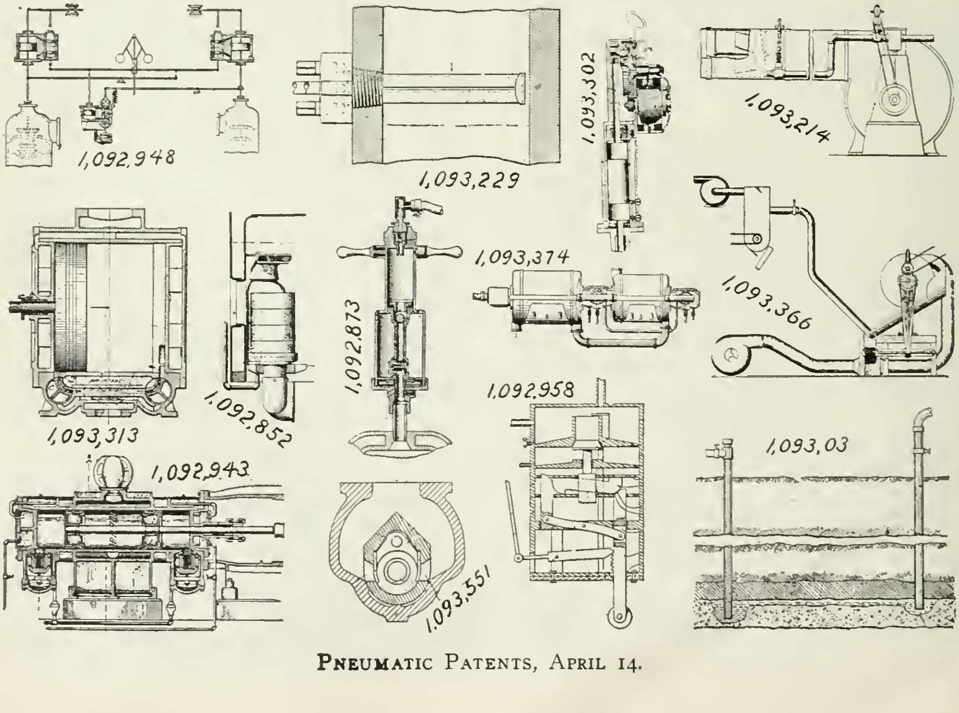


Pneumatic Patents, April 7.

produced by the said pneumatically operating means is sufficient to release the piston which is driven by the said pressure.

1,092,886. ROCK-DRILL. Charles Ernest Youmans, Yonkers, N. Y.

1. In a rock drill, the combination with two cylinders of different diameters arranged axially in line, of pistons in said cylinders, a piston rod common to both pistons and adapted to receive a tool at its end, the smaller cylinder and



Pneumatic Patents, April 14.

piston being at the tool end, the combustion end of the smaller cylinder being nearest the tool, and the combustion end of the larger cylinder being removed from the tool, and means for admitting combustible charges to said cylinders and for igniting said charges to cause the charge in the larger cylinder to drive the tool forward and to cause the charge in the smaller cylinder to retract the tool.

1,092,943. AMMONIA-COMPRESSOR. PETER NEFF, DONALD COLE, and ELBERT L. EBERSOLE, Canton, Ohio.

1,092,947. ELASTIC-FLUID TURBINE. WILHELM PAPE, Charlottenburg, Germany.

1,092,948. REGULATOR FOR MIXED-PRESSURE TURBINES. WILHELM PAPE, Charlottenburg, Germany.

1,092,949. AIR-BRAKE APPARATUS. WILLIAM E. PARKER, Manning, Tex.

1,092,958. AUTOMATIC RAILWAY-BRAKE VALVE. BENJAMIN F. SHURZ, Marion, Ohio.

1,092,982. PNEUMATIC TRANSMISSION SYSTEM. FERNAND E. D'HUMY, Englewood, N. J.

1,093,031. METHOD OF RAISING FLUIDS FROM ARTESIAN WELLS. FRANK O. BROWN, Dallas, Tex.

3. A method of raising fluids from a subterranean fluid-bearing strata, consisting in forcing compressed air into one of two wells extending into the strata and communicating at their lower ends, thereby forcing out through the other well the fluid normally standing in both wells and in the passage connecting the same, subsequently connecting either well with a receiver, equalizing air pressure in the receiver and wells, and finally pumping air from the wells into said receiver, until the air pressure in the wells becomes substantially atmospheric.

1,093,048. PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,093,114. FOUNTAIN-BRUSH. JAMES G. CORBETT, Beaver Falls, Pa.

1,093,116. GOVERNING MECHANISM FOR TURBINES. LUDWIG CUBELIC, Charlottenburg, Germany.

1,093,214. FAN OR BLOWER SYSTEM. NORMAN L. SNOW, Plainfield, N. J.

1,093,229. PITOT PLUG FOR FLUID-METERS. JAMES WILKINSON, Boston, Mass.

1,093,299. UNLOADING DEVICE FOR COMPRESSORS. WILLIAM F. TREIBER, Corning, N. Y.

1,093,302. PRESSURE-DEVELOPING PNEUMATIC TOOL. JOHN L. WAGNER, Syracuse, N. Y.

1,093,313. DRY VACUUM-PUMP. EVI WILLSON CHRISTIE, Sewaren, N. J.

1,093,366. MATCH-SPLINT-CONVEYING APPARATUS. BERNARD GEORGE VAUGHAN, Joliet, Ill.

1,093,374. PRESSURE-EQUALIZER FOR ROTARY BLOWERS. OTTO BANNER, Sterkrade, Germany.

1,093,389. SUCTION APPARATUS. JOHN C. FORD, deceased, Keokuk, Iowa, by Mary E. Brown, administratrix, Keokuk, Iowa.

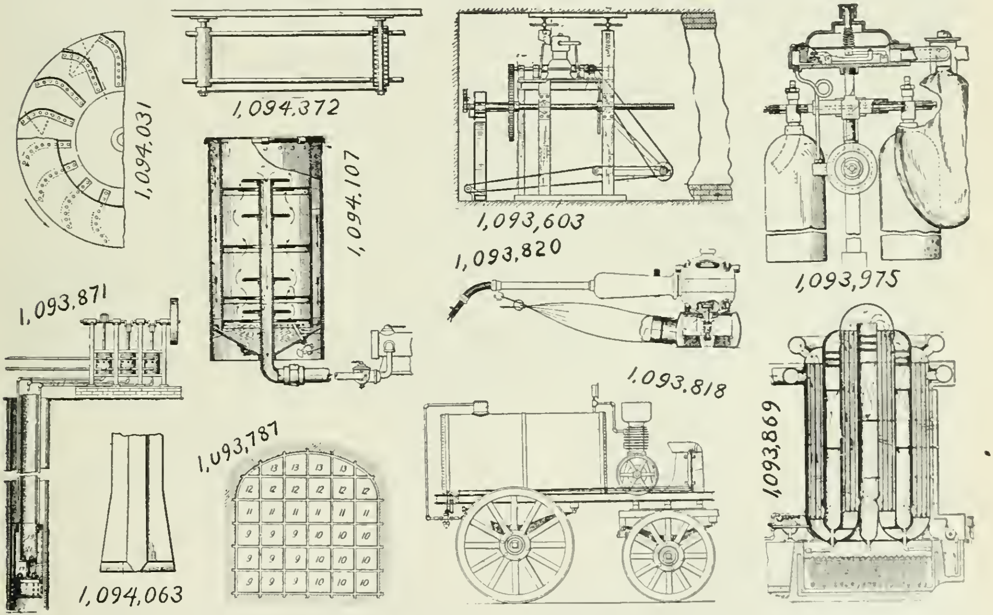
1,093,408. DRILL-CYLINDER. CHARLES C. HANSEN, Easton, Pa.

1,093,420. BLOWPIPE. CHARLES HOLDER, JR., New York, N. Y.

1,093,454. AIR-BRAKE APPARATUS. BLYTHE J. MINNIER, Watertown, N. Y.

1,093,546. PNEUMATIC VALVE. JUDSON ROGERS DE NOYELLES, Binghamton, N. Y.

1,093,551. SAND - BLAST APPARATUS. CHARLES A. DREISBACH, New Haven, Conn.



PNEUMATIC PATENTS, APRIL 21.

APRIL 21.

1,093,603. TUNNELING AND EXCAVATING MACHINE. CHARLES H. BONNETT, Port Huron, Mich.

1,093,613. AIR-COUPLING DEVICE. RUDOLPH GEISER, Toledo, Ohio.

1,093,787. METHOD OF TUNNELING. HARRY A. KUHN and WALTER W. MACFARREN, Pittsburgh, Pa.

1. A method of tunneling comprising the following steps: 1st, forming simultaneously a number of intersecting slots or channels in one half of the "head;" 2nd, forming simultaneously similar slots or channels in the other half of the "head" and at the same time removing the material previously cut, and the material between said previous cuts in the first half of the "head," and so on alternately *"ad libitum."*

1,093,818. ROAD-OILING VEHICLE. GEORGE I. WORLEY, Kansas City, Mo.

1,093,820. VACUUM-CLEANER. Chester H. Beach, Racine, Wis.

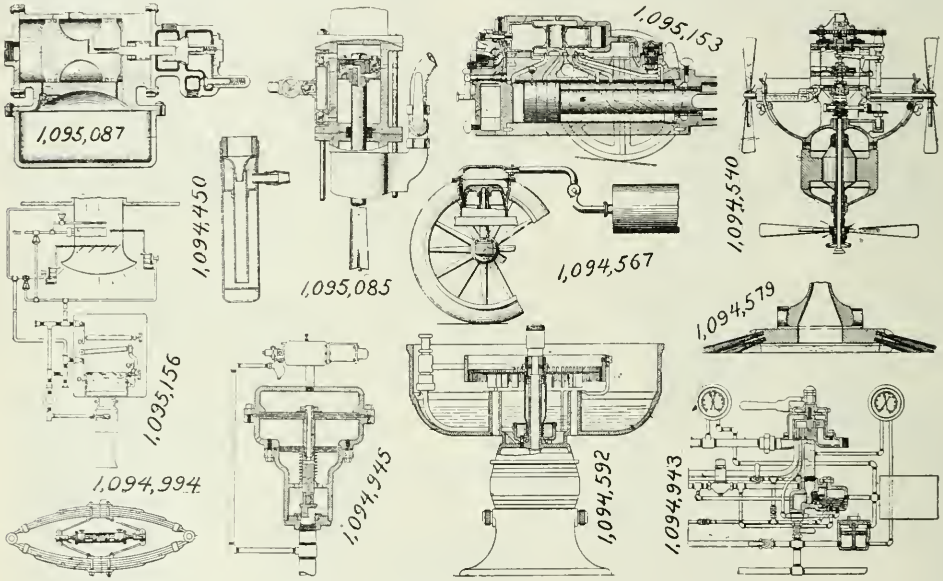
1,093,859. METHOD OF DRYING AIR FOR BLAST-FURNACES. Mark W. Johnson, Jr., Birmingham, Ala.

1. The method of drying air which consists in compressing the air, cooling it to condense the moisture contained, removing the condensed moisture, and then heating the air by bringing it into heat interchanging relation with the compressed air before the latter is cooled.

1,093,869. APPARATUS FOR DRYING GASES. Charles H. Leinert, Chicago, Ill.

1,093,871. COMPRESSED-AIR WATER-ELEVATOR. Robert Safford McIntyre, Riverside, Cal.

1. A water elevating apparatus comprising a cylinder with inlet and outlet valves and adapted to be immersed in the water to be elevated, an air cylinder, a reciprocatory piston in the air cylinder, and an air conduit of relatively small capacity connecting one end of the air cylinder to the water cylinder, the air cylinder being void of valves and having ports between its interior and exterior at that end only of the stroke of the piston remote from the end of the air cylinder connected to the water cylinder, and the water cylinder being provided with a balancing passage between its interior and exterior.



Pneumatic Patents, April 28.

1,093,975. ANESTHETIZER. Graham Clarke, Cleveland, Ohio.

1,093,989. LOCOMOTIVE-SAND-BOX ARRANGEMENT. Charles L. Heisler, Schenectady, N. Y.

1,094,031. CENTRIFUGAL FAN. Frederick R. Still, Detroit, Mich.

1,094,063. ROCK-DRILL BIT. Carroll R. Forbes, Rolla, Mo.

1. A radial wing drill bit having its wings tapered longitudinally, the said wings being flattened at their ends adjacent their outer edges.

1,094,107. AIR-WASHER. Alfred Wickersham, Sunnyvale, Cal.

1,094,195. PROCESS FOR DRYING PAPER. Edward P. Butts, Springfield, Mass.

The process of drying paper with air having a predetermined moisture absorbing capacity, which consists in first effecting the saturation of the air by direct contact with water having a definite temperature, then directing the saturated air against an obstruction to separate therefrom the surplus of water, then directing the air against a heated surface having a definite temperature to effect the expansion of the air, next liberating the dried and heated air and causing it to pass over the paper to be dried, and finally collecting the moisture laden air to again be saturated and used as herein stated.

1,094,351. PNEUMATIC VALVE MECHANISM. William Arthur Watson, Malden, Mass.

1,094,372. AUTOMOBILE PNEUMATIC SPRING. Abi Mayerson, Pueblo, Colo.

APRIL 28.

1,094,450. MASSAGE APPARATUS. Herbert E. Marcy, Mount Vernon, N. Y.

1,094,521. AIR-FILTER. Max Brauer, Berlin-Wilmersdorf, Germany.

1,094,522. FLUID-MOTOR OR THE LIKE. Louis H. Brinkman, Glen Ridge, N. J.

1,094,540-1. FAN. Charles H. J. Dilg, New York, N. Y.

1,094,567. PNEUMATIC SPRING FOR VEHICLES. Josef Hofmann, Baumaroche, Switzerland.

1,094,579. VACUUM CLEANING-TOOL. Frank J. Matchette, Milwaukee, Wis.

1,094,592. AIR-MOISTENING APPARATUS. Carl Heinrich Prott, Rheydt, Germany.

1,094,808. PNEUMATIC PLAYER-ACTION. Gustaf W. Paulson, Belmont, and Rudolf Paulson, Boston, Mass.

1,094,943-4-5. AIR-BRAKE SYSTEM. Jacob Rush Snyder, Pittsburgh, Pa.

1,094,994. AIR-COMPRESSOR. Floyd E. Hufford, Milford, Ill.

1,095,085. DRILL. John Thomas Curnow, Palatka, Mich.

1,095,087. AIR-BRAKE APPARATUS. William R. Davis, Columbus, Ohio.

1,095,153. DIRECT-ACTING ENGINE. Albert Ball and Thomas Officer, Claremont, N. H.

1,095,156. APPARATUS FOR CONTROLLING THE HUMIDITY AND TEMPERATURE OF AIR. Willis H. Carrier, Buffalo, N. Y.

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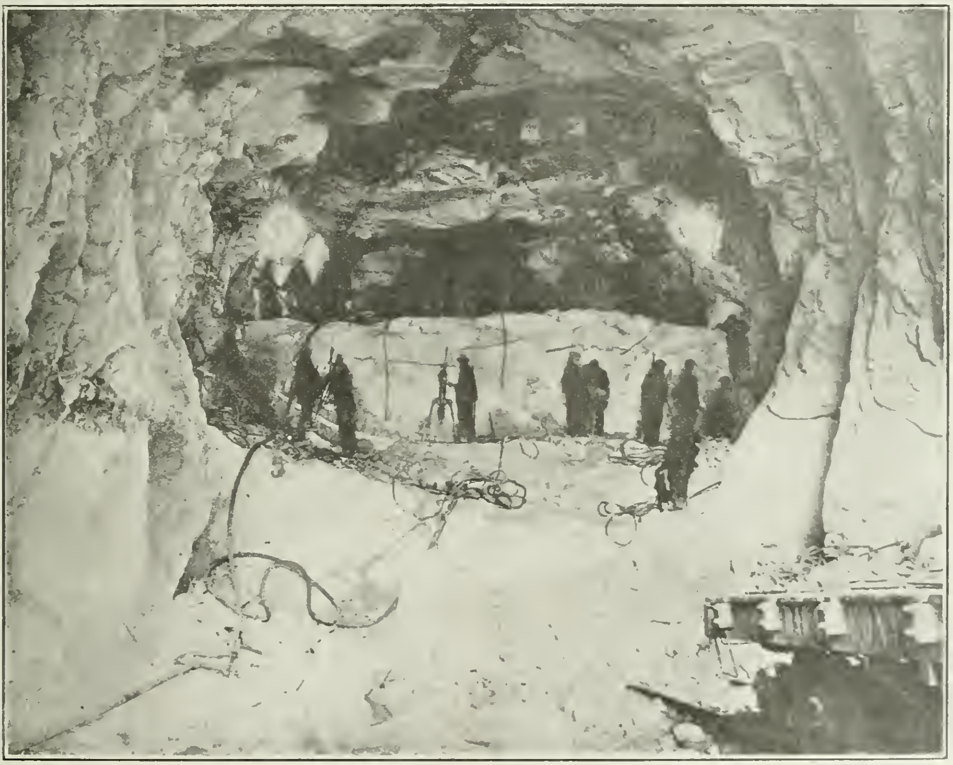

FIG. I. HEADING AND BENCHES. YADKIN RIVER TUNNEL.

AN UNUSUAL DEVICE IN DAM CONSTRUCTION

BY FRANK RICHARDS.

A scheme of water power development of unusual interest, it being one of considerable magnitude with some features of novelty, is now in process of execution on the Yadkin River, near Whitney, N. C., for the Southern Aluminum Company. It is computed that 120,000 horse power will be developed.

The entire construction is undertaken by a single contractor, the Hardaway Contracting Company, Inc., and the work comprises the building of a dam 227 feet high, from the lowest point of the river bed, and 1,300 feet long, a power house 60 feet by 600 feet and the preparation of the factory site for the Aluminum Company. The work will require 650,000 cubic yards of excavation and about 450,000 cubic yards of masonry.

In connection with the construction of the dam a novel arrangement has been adopted for the diversion of the flow of the river until the work is completed. Near the eastern end of the dam two shafts or wells are sunk, 60 feet in diameter at the top and 40 feet at the bottom, these connecting with two horizontal tunnels, each 40 feet wide and 34 feet high, which pass through the mountain that forms the east bank of the river. Through the wells and tunnels the entire flow of the river can be discharged during the construction of the dam. The wells will be closed by gates when the pond is to be filled and the water power utilized. In case of unusual floods in the river these gates can all be opened and a large portion of the surplus water can be carried off in this way.

Although the job is necessarily of a temporary character, the contractor's operating plant, the largest on record in the South, is intended to embody all the up to date conveniences and economies. From 6000 to 8000 horse power is required, and a standard transmission line, with steel towers and two independent copper lines, has been built from the line of the Southern Power Company at Albemarle, a distance of about seven miles.

The air compressing plant comprises four Ingersoll-Rand, Class PE, direct connected, electrically driven two-stage machines, with an aggregate output of 11,000 cu. ft. of free air per minute, delivered at 100 lb. gage pressure. In connection with the large and efficient intercoolers on these machines separators are provided to remove all the liberated water from the air before it enters the high pressure cylinder. While these compressors run at constant speed, automatic clearance controllers regulate the output according to the demand, without any sacrifice of power for work not done. Fig. 2 shows the air cylinder ends of these machines.

Following naturally in the list of equipment come 40 Leyner-Ingersoll rock drills with their mountings and appurtenances. There are 7 steam shovels, 17 forty ton American locomotives, 20 twelve yard Western Wheeled Scraper Company steel side dump cars, 10 standard steel, 100,000 lb. capacity, flat cars, 30 twenty ton American Hoist and Derrick Company steel guy derricks, with 115 feet mast and 100 ft. boom, operated by 40 H. P. Lidgerwood engines.

Every effort has been made to have the plant for crushing stone, and mixing concrete as complete and efficient as possible. There is one No. 21 Gyratory crusher, with six No. 6 crushers of the same type, four 54 in. sand screens and four 2 yard mixers, with the necessary elevators and screens. The mixers were furnished by the Municipal Engineering & Contracting Company of Chicago, and all the crushers, screens, elevators, and electric motors for running the plant were furnished by the Allis Chalmers Manufacturing Company, Milwaukee.

Incidentally it may be mentioned that the wheel machinery for the Aluminum Company's power house is to be furnished by S. Morgan Smith Company, York, Pa. The electric machinery will be furnished by the General Electric Company and the flume work by the Holyoke Steam Boiler Works, Holyoke, Mass.

As one of the first requirements in the arrangement of operations, the two tunnels spoken of are nearly completed, and the admirable photo, Fig. 1, taken at a favorable stage of the work, tells so clearly the story of the method followed as to make detailed explanation superfluous. As the tunnel section was much larger than that of any double track railroad tunnel there was ample room to work, and the rock was so solid that no timbering was required.

First a heading was driven of sufficient height for comfortable working, and this was followed by two benches, the drills being mounted upon columns for the first operation, while tripods were used for the remainder of the work. In the picture the principal actual work noticeable is the drilling on the lower bench. The end of a standard platform car is seen at the lower righthand corner, and the projecting portion of the rail upon which the car stands indicates the bottom of the tunnel.

The work requires much more rock cutting, besides that in the shafts and tunnels, and there may be opportunity for another interesting story later. The complete elimination of the water trouble at the beginning was an immense advantage.

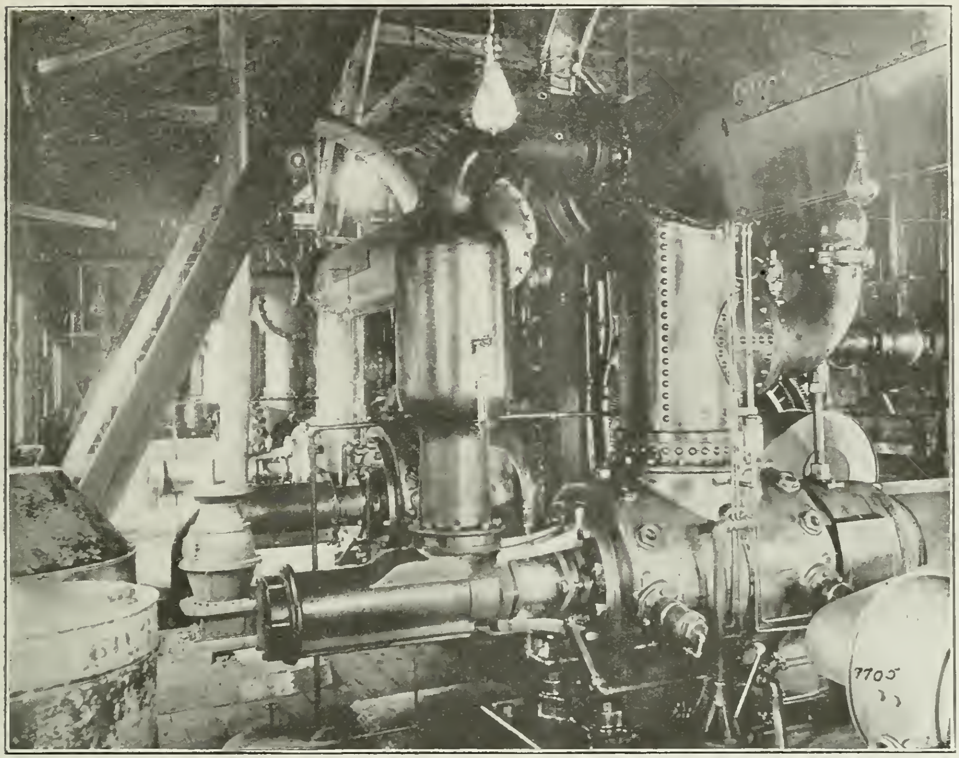

FIG. 2. COMPRESSORS FOR YADKIN RIVER DAM.

All the information here given is supplied directly by Mr. B. H. Hardaway, President of the Hardaway Contracting Company, Incorporated, Whitney, North Carolina.

HIGH PRESSURES

Investigations with very high pressures have lately been made by Dr. Bridgeman of the physical laboratory at Harvard University, and he has probably been experimenting with higher pressures than have ever before been reached. In some of his experiments he obtained a pressure of something like 300,000 pounds per square inch, and succeeded in measuring the pressure with reasonable accuracy up to 175,000 pounds per square inch. What these pressures mean will be understood when we consider that the highest pressures commonly produced are those exerted by the explosions in modern arms with smokeless powder, where a pressure up to 30,000 pounds or more per square inch is developed when the gun is fired. Pressures of 200,000 pounds per square inch have been produced by exploding nitro-glycerine in a closed vessel.

THE PORTLAND CANAL TUNNEL

BY LLOYD C. WHITE.*

The driving of the Portland Canal tunnel was not an important operation either as to costs established or rate of progress; but, on account of its being the largest undertaking of its kind in the district, the methods and costs may be of interest. The work was carried on by the Portland Canal Tunnels, Ltd., a company with head offices at Victoria, British Columbia. The power-plant of the Portland Canal Mining Co. was leased for the work, and this expense is not included in the following costs. Also the underground equipment is entirely written off.

PURPOSE OF THE TUNNEL.

The portal of the tunnel is situated about 3½ miles north of Stewart, British Columbia, and is 300 ft. above sea-level. The objects of the tunnel are to provide a working entry to the mines located in the Portland Canal fissure zone, and to provide a means of further exploring veins in this zone; also to develop water power.

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*Mining and Scientific Press, San Francisco

The heading, 7½ by 8 ft. in the clear, was driven a distance of 2916 ft. at an average rate of 8 ft. per day. The best weekly record was 67 ft., and the best monthly 271 ft. Two 8-hr. shifts per day were employed, consisting of four machine-men and three shovelers. After the 1000-ft. mark was passed, four shovelers were employed. Compressed air at 100 lb. pressure was supplied by a water-driven, 520-cu. ft., Rand class D-2 compressor, and delivered into the tunnel through a 4-in. pipe. Two 3¼-in. Ingersoll-Rand E-44 drills, mounted on a 7-ft. single screw bar were used. Miners and shovelers started work together. The bar was set up above the rock pile, and from 10 to 12 holes were drilled from this position. By this time the rock was out, the bar was lowered, and three lifters were drilled. The first 1600 ft. of the tunnel is in greenstones, while the remainder is in argillites, quartz and porphyry. With but two exceptions during the entire work, a round was drilled every shift. Five-foot rounds were drilled, but seldom "bottomed."

Three 20-cu. ft. cars were used, and tramming was done by the shovelers. The track, of 20-lb. rails, 18-in. gage, and ½% grade, was laid on the left-hand side of the tunnel. One switch, about half way in, was used; the empty incoming car was taken off the track near the face to allow the loaded one to pass. At a point 730 ft. from the portal an 80-ft. adit was run, opening into a canon. This not only made an excellent dumping place, but shortened the tramming distance by 750 ft The shovelers laid and leveled the track. The floor from within 3 ft. of the face to 40 ft. back was covered with steel plates before blasting. A drain 12 in. deep was made on the right side of the tunnel, the lifter being drilled low for this purpose.

Ventilation was provided by two Schutte & Koerting blowers. The ventilating line consisted of 10-in. diameter, 24-gage, galvanized pipe. The pipe was made in 10-ft. lengths, with riveted joints, painted with tar, and wrapped with muslin. The compressor was run two hours after blasting to clear the tunnel. After the 2000-ft. mark was reached, more or less trouble was experienced with the ventilation, especially in rainy weather. Except in a few places the tunnel was dry, and after the first 140 ft. required no timbering. The writer, who had charge of the work, was the only boss. The tunnel is still being driven, but only as a 5-ft. drift and secondary to exploration on veins found in the tunnel.

All supplies were bought at Vancouver, British Columbia, and came north by steamship. The prices of some of the more important supplies at the tunnel were as follows: 40% dynamite, $0.134 per pound; 60% dynamite, $0.159 per pound (powder was used in about the proportion of 30% of the former to 70% of the latter); 20-lb. steel rails, $72.24 per long ton; blacksmith coal, $27 per ton. The scale of wages is as follows: machine men, $4; shovelers, $4; blacksmith, $5; compressor men, $5.

AVERAGE TIME OF OPERATIONS

	Hr.	Min.
Picking down—Setting up	1	00
Drilling from upper set-up	4	30
Shoveling back—Lowering bar	0	30
Drilling from lower set-up	1	15
Tearing down	0	10
Blowing out holes	0	5
Loading	0	15
Total	7	45

DETAILED SUMMARY OF COSTS

	Total cost.	Cost per foot.
Labor:		
Machine men	$11,526.00	$3.953
Shovelers	10,711.00	3.673
Timbering	753.17	0.258
Drainage	123.00	0.042
Ventilation	224.50	0.077
Ties and wedges	394.60	0.135
Compressed-air line	210.00	0.072
Compressor men	3,398.35	1.166
Blacksmith and helper	3,546.50	1.216
Superintendent	2,554.00	0.876
Total	$33,441.18	$11.468
Supplies:		
Powder	$ 7,469.25	$2.562
Fuse	391.50	0.134
Caps	92.00	0.032
Candles	421.90	0.145
Blacksmith coal	364.50	0.125
Machine drills and parts	1,464.77	0.503
Drill steel	343.57	0.118
Timbers	150.00	0.052
Repairs on compressor	77.40	0.027
Oils	97.00	0.031
Miscellaneous	216.00	0.073
Total	$11,087.89	$3.802
Equipment:		
Muck sheets	$ 110.00	.....
Steel rails	1,290.00	...
Ventilators	225.00	.....
Ventilating pipe	960.00	.....
Compressed-air line	1,070.00	.....
Cars	400.00	.....
Total	$ 4,055.00	$1.391
Length of tunnel		2916 ft
Total cost		$48,584.01
Cost per foot		$16.661

NEW ST. PAUL TUNNEL THROUGH THE CASCADE MOUNTAINS*

The Chicago, Milwaukee and St. Paul Railway is now driving a tunnel 11,902 ft. long through the summit of the Cascades, between Rockdale, Wash., and Keechelus, 60 miles east of Seattle, which will effect a saving of 3.6 miles in distance, will eliminate 443 ft. of rise and fall and 1,239 deg. of curvature, the elimination of snow troubles being another important consideration.

The tunnel is being built for single track on a grade of 0.1 per cent. ascending from the east end for 2000 ft., and then descending on a 0.4 per cent. grade to the west portal. It is on tangent for the entire length with a 6 deg. curve at the east end and a short 3 deg. curve at the west portal. The new line crosses under the old about 1000 ft. in from the east portal.

METHOD OF CONSTRUCTION.

Before deciding upon the method to be adopted in driving this tunnel the relative advantages of the top heading method generally employed in this country and of the bottom heading, or European, method were studied. The bottom heading was determined upon as most economical because of the ability to trap the material above the first drift directly into cars, whereas the removal of a lower bench by large shovels or other power equipment was difficult if not impractical in a tunnel of this section and length.

An advance heading, 8 ft. by 13 ft., is first driven on subgrade at one side. A second crew then follows, breaking this heading out to the full width of 18 ft. This is timbered with 12 in. by 12 in. posts capped by 12 in. by 14 inch timbers at intervals of 5 ft. Following the timber, vertical openings are driven to the arch ring of the completed tunnel at intervals of 150 ft., and the excavation is pushed from these openings in each direction, drilling and blasting the entire face. The material is broken down on to the timbering and is trapped into narrow gage cars on the lower level.

In driving the heading four Ingersoll-Rand, 3⅝ in. piston type air drills, weighing 410 lb each, are mounted on one crossbar and are operated simultaneously. This crossbar is set up about 4 ft. above subgrade. When working in ordinary rock 16 holes are drilled to a depth of 8.5 ft., 12 of which are above the crossbar, with 4 lifting shots beneath. Ordinarily the holes are not sprung, although in some instances when working in unusually hard rock it has been necessary to spring the holes twice. From 3½ to 9 boxes of 60 per cent. powder is set off in each set of 16 holes and is fired entirely with fuses. The average horizontal break is 7.3 ft. and the material generally is broken so that it can be handled readily. With the material encountered so far about 8 lb. of powder are required for each cubic yard of material shot from the heading.

The floor of the heading is covered with steel plates which are moved forward before each shot so that the material will fall upon them and be more readily loaded. In the lower heading and side drift a steel rocker car of one cubic yard capacity is used. This car is 3 ft. high and 4 ft. wide and was designed to operate in limited space. Peteler 1½ yd. side dump cars are employed for the removal of the material trapped down from the bench. Two tracks are laid with 56 lb. rail to the face of the heading, with frequent cross-overs. Horses haul the cars as far as the outer face of the bench, from which point they are handled with gasolene locomotives. All material from the tunnel is wasted at the portals.

When working in average material one round is shot every 12 hours in the heading. This time is divided approximately as follows: Three hours taking down roof and removing muck from the face of the heading. Thirty minutes setting up the cross bar and getting the drills into position. Seven hours drilling and removing the muck. Thirty minutes taking down machines and loading and firing shots. One hour clearing heading of smoke and gas. To accomplish this a force is employed on each shift consisting of four drill runners, four helpers, ten muckers, one nipper and one shift boss.

From six to ten bench openings are worked at one time, giving double that number of working faces. In this way the drill runners move from one face to another and work continuously, while on the heading they assist in throwing the material away from the face to expedite the work.

In general, the material encountered has been hard black slate. However, about 5,000

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*Abstract from *Railway Age Gazette.*

ft. in from the west end a hard conglomerate with a large proportion of silica was encountered. With this considerable water was also found. The first 400 ft. in on the west end was a debris formation which also carried considerable water. However, between these two places sections as long as 1,500 ft. were found with no water whatever. Because of the hard character of the material on the west end it was necessary to replace the drills weighing 175 lb. with heavier ones weighing 410 lb., although on the east end new Ingersoll-Rand drills weighing only 110 lb., with a new valve motion, ("Butterfly,") and striking 600 blows per minute, are being tried out.

At the east end the work is being handled differently because of a large approach cut. To save time a heading is being driven at the upper level which will be continued to a junction with a bore from the west end. After the approach cut was completed, a second heading was driven at the track level, with shafts at various points extending to the upper heading to facilitate the handling of muck from the bench.

VENTILATION.

To provide ventilation and to remove the powder gases from the headings promptly one 12 in. ventilating pipe extends from the power house at the west portal to the face of the heading. Air is forced through this line by a high-speed fan with a capacity of 4,500 cu. ft. of free air per minute, direct-connected to a 25 h. p. steam turbine. A high-speed helper fan, with a capacity of 4,500 cu. ft. of free air per minute, direct-connected to a 20 h. p. electric motor, is located 2,500 ft. in from the west portal. To remove the dead air a 24 in. pipe line leads out from the bench. This is connected to a 72 in. slow speed exhaust fan driven by a 30 h. p. motor. As the bore is driven further in additional ventilation will be provided by adding more helper fans on both the exhaust and blower lines. A similar system is in use at the east end, the only important differences being that the exhaust fan is direct-connected to a 40 h. p. steam engine and the blower line is 17 in. in diameter, instead of 12 in., at the west end.

CONCRETE LINING.

It is planned to line the tunnel with concrete for its entire length before it is turned over to operation. This work was begun at the west end July, 1913, and is now being begun at the east end. It is anticipated that forces working from the two ends will meet about 8,000 ft. in from the west portal, and methods for transporting the material are being figured on that basis. All concrete is mixed at the portals and is hauled in trains of 4 steel cars of 18 cu. ft. capacity each. These cars are moved by a ¾ in. cable operated at a speed of four miles per hour. Each car is equipped with a cable gripping device which is automatically released at the proper point by a trip.

POWER PLANT.

The power plant at the west end consists of three oil-burning, 150 h. p. boilers, which operate two straight-line, single-stage Ingersoll-Rand air compressors, with a capacity of 807 cu. ft. of free air per minute each, and one straight-line, two-stage Ingersoll-Rand air compressor with a capacity of 790 cu. ft. of free air per minute. These boilers also provide steam for a 200 h. p. engine belt-connected to a 100 kw., 500-volt d. c. generator, furnishing power for the motors operating the fans and for the Leyner drill sharpeners and other tools in the shops. This generator also supplies current for lighting the tunnel, using a three-wire system of distribution, which allows a voltage of 250 to be used. A 3 kw. balancing set is installed in this circuit. Extension cords are provided at the various faces where blasting is being done.

At the east end three 125 h. p. boilers are installed. These boilers also operate on fuel oil, which is delivered from the main line one-half mile distant into two 20,000 gal. timber oil sumps and is then carried through a 6 in. wood stave pipe line to a 35-barrel service tank at the power station. These boilers operate two Laidlaw-Dunn-Gordon duplex two-stage air compressors with a capacity of 1,030 cu. ft. of free air per minute each, and one 180 h. p. engine direct-connected to a 75 kw., 500 volt, d. c. generator. The lighting system here is practically the same as that at the west end

ORGANIZATION.

The construction of this tunnel is being handled entirely by company forces. With the exception of the shift bosses, who work 12 hours, the work is carried on continuously in three shifts, six hours on and 12 hours off. The concreting force is divided between two shifts of 10 hours each. Normally, about 250 men are employed in the tunneling operations in each end, and 80 men are engaged in placing the concrete lining at the west end.

The men engaged in driving the heading

are paid a bonus based on 10-day periods For each foot of heading driven over 100 ft. in this period each man is paid one hour overtime. This practice has been found to work out very satisfactorily, as it tends to expedite work and to hold the men as well. Under favorable conditions the men have made as much as 60 hours overtime in 10 days. The best progress made in the west heading for one month to date was 450 ft. and on the west bench 600 ft. Among other measures taken to safeguard the men, a pulmotor with several oxygen helmets is provided at each portal.

The heading at the west end of the tunnel is now in about 6,500 ft., while that at the east end is in about 3,500 ft. At the present rate of progress these headings should be connected about July 15, and the tunnel should be completed, including the concrete lining, by the end of the year. About 3,100 lineal ft. of concrete lining has been placed to date, comprising about 18,500 cu. yd.

The work is being done under the direction of C. F. Loweth, chief engineer, and E. O. Reeder, assistant chief engineer. J. I. Horrocks is engineer and superintendent of construction in direct charge of the work on the ground.

WANTED—AN AIRBRAKE STORY

For the purpose of obtaining from railroad officials and employes authentic information of interest and value the Westinghouse Air Brake Company, of Wilmerding, Pa., offers $2000, divided into prizes of $1000, $500, $200, $150, $100 and $50, for the best written narratives of airbrake performance in the actual service for any period. The awards will be made by an independent committee of three judges, consisting of prominent persons not associated in any way with the Westinghouse interests. The stories must be based upon actual personal experience or observation of the writer or on information obtained first hand from railroad men who actually know and can substantiate the facts. No article shall contain more than two thousand words. It should be addressed to the "Judges of Prize Contest," Room 2121, 165 Broadway, New York City. For additional information see the booklet available on request from the Westinghouse Air Brake Company, Wilmerding, Pa., containing the rules and conditions governing the competition. The closing date is August 1, 1914.

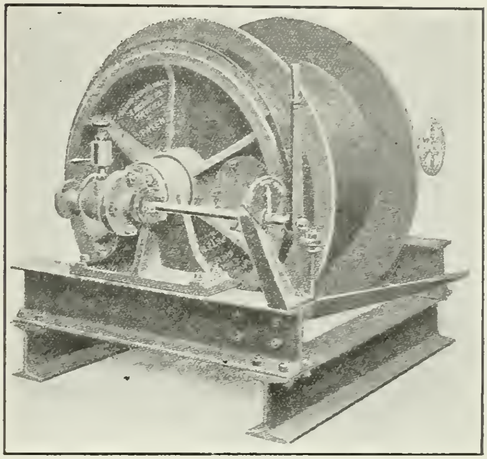

FIG. 1.

A SELF CONTAINED COMPRESSED AIR HAULAGE AND HOISTING DRUM

A novel and interesting haulage and hoisting drum, built by David Ashton & Co., Sheffield, Eng., is shown externally in the half tone, Fig. 1, and in detail in the line cuts following. The drum is driven by compressed air and the motor, consisting of three single acting cylinders thrusting on a fixed crank pin, is entirely within it. The only external parts, as seen in Fig. 1, are the vertical starting and reversing lever, the friction clutch and the hand brake.

Fig. 2 is an unshaded sectional elevation of the drum. The non-rotating crank shaft contains two air passages, A and B, communicating with the air chest C through the slide valve D can be moved to admit air through either of these passages and at the same time connect the other with the exhaust. This valve is used only for reversing or stopping the engine and, by means of a rack and pinion, is operated by the control lever.

Two ports shown in section in Fig. 3 form a communication between the passages A and B and the passages E attached to and revolving with each cylinder. The flaps F F^1 perform the air distributing function. If, say, the passage A is acting as inlet, the air pressure keeps the flap F in the position shown in Fig. 3, and the cylinders, rotating in the direction of the arrow, the air is cut off at about two-thirds stroke. The flap F^1, however, partially covering the exhaust passage B,

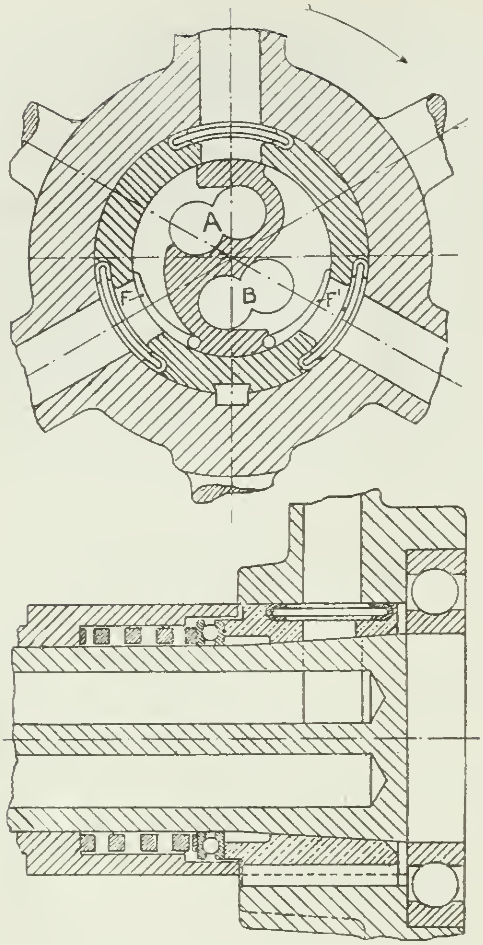

FIG. 3.

automatically falls and allows the exhaust to continue throughout the stroke. On reversing the engine the flap F falls and F^1 rises, giving the cutoff on the admission stroke.

The cylinders are carried between two discs mounted to turn on the crankshaft on ball bearings. On the boss of the right hand disc is fixed a phosphor bronze pinion J gearing into a larger pinion K, which latter is mounted in ball bearings on an arm attached to a sleeve L. The sleeve L surrounds the fixed crank shaft, and on it is keyed the clutch pulley M, which can be held or released by a friction band operated by a hand wheel on the right side of the drum. When the sleeve L is held by the clutch, the movement of the pinion K is transmitted to an internal gear wheel mounted on the inner side of the drum side P through the pionion N, thus revolving the drum with a double reduction of speed.

When the clutch M is released the sleeve L revolves with the engine, the pinion N runs idly around the interval gear and the engine and the drum can rotate independently. This arrangement allows the drum to run freely when lowering down an incline.

The engine can be easily removed by taking off the pedestal supporting the clutch and the drum side P, when the complete engine and gearing can be slid out of the drum. The ease and accuracy with which the drum can be manipulated is remarkable—by working the reversing lever a movement of a few inches of the drum can be obtained without difficulty, and the engine can be reversed under load at full speed without danger. Practically all moving parts run in an oil-bath absolutely free from dirt; the over-all dimensions are less than those of any gear having external engines; there is no possibility of the rope fouling the gearing or of fingers getting trapped; no interference with the engine by unauthorized persons can take place; there are no stuffing boxes; on account of the simple cut-off arrangement, the air consumption is low, and the power in relation to cylinder diameter is increased by the high speed at which the engine runs and the efficiency of the gearing, which is perfectly lubricated.

The drum illustrated is the smallest of three sizes made, particulars of which follow:—

	Size.		
	No. 1	No. 2.	No. 3.
Drum diameter .... Inches	18½	26	33
Barrel width Do.	16	20	24
Cylinders ...Do.	5 by 2½	6½ by 3½	8 by 4½
Cubic feet of air used per minute.........	50	84	146
Pounds pull on rope	1,000	1,800	3,000
Horse-power	9	16	27
Outside dimensions...Inches	30 by 30 by 30	42 by 42 by 42	54 by 54 by 42
Revolutions of engine	700	550	400
Weight ...Cwt.	15	25	35

What is said to be the highest dam in Europe has just been completed across the River Bober, near Hirschberg. It is 204 ft. high, 164 ft. wide at the base, and 24 ft. at the top, with a curved plan, concave to downstream, of a radius of 820 ft. It contains about 9,000,000 cu. ft of stone masonry and cement. There are a spillway 280 ft. wide and two outfalls at the base 4 ft. 11 in in diameter.

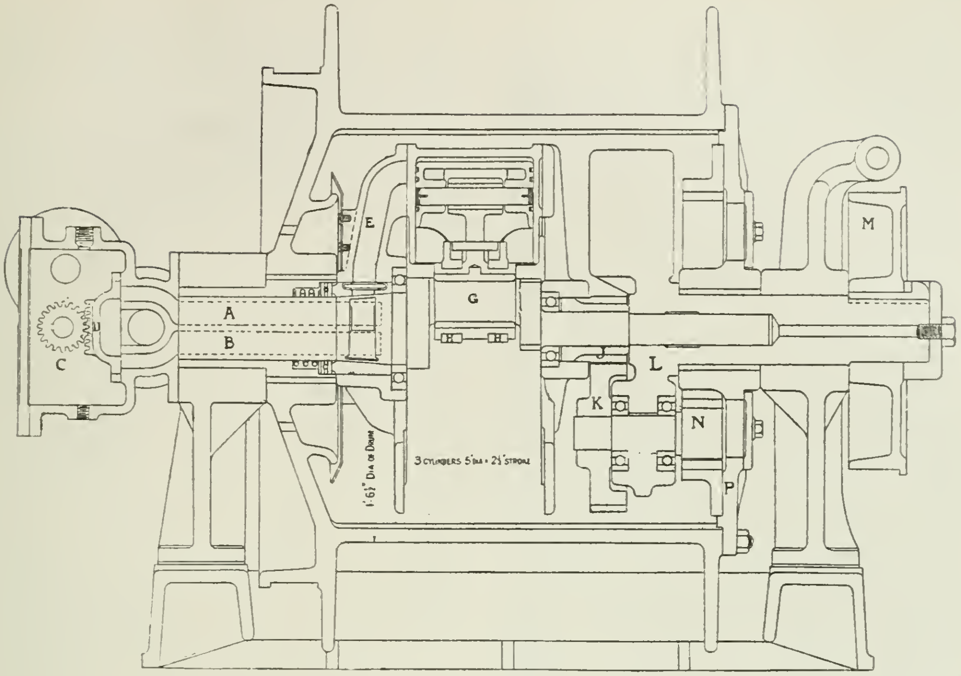

FIG. 2.

OXY-ACETYLENE CUTTING AND WELDING

BY H. P. HARDING.*

THE CUTTING OPERATION.

In the cutting torch several small oxy-acetylene jets pre-heat the work for an additional jet of oxygen, which does the cutting by a high rate of oxidation. Part of the metal is removed as an oxide, and the heat of combustion melts the rest so that it runs out of the cut.

Theoretically the proportion of the gases is two of acetylene to five of oxygen, which combine to form four volumes of carbon dioxide plus two of water vapor. This reaction is not completed in the inner cone, because the temperature is above their disassociation point, so further combination occurs in the outer envelope. Most of the oxygen in this second step is taken from the surrounding air.

The tip of the inner cone is the working point of the flame. Although its total heat is less than that of the envelope, the outer being very much larger, the heat in the envelope is not wasted. Instead, it serves three functions: to pre-heat the work for the inner cone; to prevent the inner cone being cooled by the inert nitrogen of the air; and to protect the molten metal from oxidation, the combining carbon monoxide and hydrogen having a greater affinity for oxygen than the metals.

THE WELDING OPERATION.

In operating the welding blowpipe the flames should be kept neutral; that is, there should be no excess of acetylene, which would tend to carbonize the metal, nor should there be an excess of oxygen, which would tend to oxidize it. Excess acetylene can be detected by the double inner cone, one cone being longer and less luminous than the other. An excess of oxygen can be detected by the feathery end of the inner cone. Further, a carbonizing flame will cause the metal to glow, while an oxidizing flame will cause the metal to boil. The amount of the gases admitted to the blowpipe is controlled by a regulator, which serves the function of a reducing valve to maintain any set constant pressure, not exceeding that of the source of supply. A gage on the blowpipe side of the regulator indicates the torch pressure. A gage can be used on the supply side of the regulator to indicate the depletion of the compressed gas in the cylinder.

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*Illinois Gas Association.

The high temperature of the oxy-acetylene flame enables the operator to bring the metal to a molten condition before the heat is conducted or radiated away. Some of the heat is conducted away, but it is not entirely lost since it assists in reducing trouble from expansion and contraction in the surrounding body. The envelope starts heating the body in advance of the actual work at the point of the inner cone.

EXPANSION AND CONTRACTION STRAINS.

Internal strains are always set up in every process of welding, due to the expansion and contraction when a metal body is heated and cooled. When the parts are restrained members of a structure, the internal strains set up are often sufficient to crack the metal. This is more especially true when welding hard brittle, inelastic metals, such as cast-iron. When the local strains exceed the strength of the material, fracture is bound to occur in one or more sections of the body. The more ductile the material is, the better it is capable of withstanding strains of this sort.

To relieve a welded piece of these strains, it is desirable to pre-heat before and re-heat after welding. Molecular rearrangement will then bring forth a redistribution, if not an actual elimination of the excessive strains. This treatment is very essential for cast-iron, but it is not as important for steel or wrought-iron. For large work it is usually impossible to heat the entire body. However, it is very desirable to heat the work for a considerable area around the welded portion, both before and after welding.

WELDING SHEET METAL.

In welding sheet metal of greater thickness than ⅛ in., it is advisable to cut a "V-groove" along the edge to be welded to permit penetration of the flame. It is usually necessary, except with thin sheets, to add metal from a filler rod or wire of the same or similar material. After the metal at the joint is in a running condition molten metal is added drop by drop from the filler rod until the groove is entirely filled. Sometimes an excess is added to insure the strength of the weld. If dissimilar metals are to be welded, a welding rod of the one which welds at the lowest temperature is used so that the added metal will not chill when falling upon the molten metal.

Flux is used when welding cast-iron, aluminum, brasses, bronzes, etc., to prevent oxidation, to remove the scale, and make the metal more fluid.

The strength of the weld is invariably greater than 85 per cent. of that of the original material. This difference is due to the inferior material of the welding rod or to the internal strains set up by expansion and contraction.

The structure of the weld is not quite as homogeneous as other parts of the piece welded. This is controlled largely by the skill and workmanship of the operator who can, at will, make the weld more or less homogeneous. By hammering at the right moment on the welded part, the metal can always be made denser, thus increasing the strength of the weld. A skilled welder uses the hammer as freely as he does the blowpipe.

It has been advocated of late to license operators and plants for boiler work. At the present time this would not be practicable because there are a number of cheap equipments on the market which it would not be possible to give proper instructions to the operator.

It is safe to say that one system or the other of flame welding is rapidly making its way into every branch of the metal working art. This is particularly true of oxy-aceylene welding. From a standpoint of the volume of work done, America leads the world, with Germany second, France third, and England a rather poor fourth. In scientific research and special development Germany leads all other countries. This is partly due to the fact that the German government has established schools at various places where the art is taught as one of the applied sciences.

PIPING.

As one feature of the work being carried on in Germany it might be mentioned that piping of all sizes and character is now being made by rolling from flat plate and welding by means of the oxy-acetylene torch. Piping is also being laid without the use of threads or flange joints. In this way they are enabled to use pipe of about one-half the thickness of our standard pipe, thereby saving greatly in material costs. To show what the German government thinks of this class of work, it is merely necessary to mention that at Cologne in the Palace of Justice Building, recently completed, there are nearly seven miles of piping in which there is not a single threaded joint, all being welded by oxy-acetylene.

At the Panama-Pacific Exposition, which will soon be held in San Francisco, a very interesting feature of the construction of gas and water piping is that every joint throughout the entire grounds has been welded with the oxy-acetylene blowpipe, thus eliminating the use of a large amount of additional iron necessary for fittings and simplifying the construction of gas piping considerably throughout.

We understand that in Germany a great deal of piping of all kinds is welded, even in large buildings and manufacturing plants. When the operator wishes to connect a branch to the main line, he merely applies the cutting blowpipe, cutting out a hole of the proper size and welding it to a nipple. He has a small portable equipment and the work proceeds very rapidly and not only is the line absolutely tight, but the weld is of nearly as great strength as the original piping.

IN THE GAS BUSINESS.

An instance which should be of considerable interest to the gas manufacturer is the welding of lamp posts in Dayton, O. During the recent flood in Dayton about 150 of the ornamental cluster lamp poles were broken off about 18 in. above the ground. The breaks were not due to defective castings, but to the heavy objects which were swung against the poles by the current through the streets. To take up the concrete in the street and reset the poles would have been a very expensive operation, therefore the oxy-acetylene blowpipe was used, and the poles welded efficiently and economically. A special derrick was used on which were mounted an acetylene generator and the oxygen cylinders with the necessary tools. The wagon was backed up to the stub of each pole, the broken part raised to its original position, the old breaks were matched up and the joints prepared for welding. The weld was probably stronger than the original casting, as one-eighth inch fillet was added to the metal at that point.

In Canton, Ohio, and in many other cities there are a great many lamp posts which are constructed of sheet metal attractively fluted and pressed to make a well-designed post. In the manufacture of these columns, a sheet of the proper size is selected, suitably tapered and the longitudinal seam welded with the blowpipe. After the welding has been accomplished the fluting is placed in the metal by use of dies of various kinds, the base and top of the columns are suitably pressed to give a pleasing appearance. Such posts are very much lighter than the ordinary castiron posts, and are practicably indestructible and, if desired, may be filled with cement or concrete, which gives a very substantial construction.

In direct connection with gas manufacturing plants there are of course many operations to which the blowpipe may be applied with economy. Among these are the repairing of furnace door frames, large heavy posts, hydraulic rams, pumping machinery, wrecking of old gasholders, structural work, etc., cutting of manholes through steel tanks or required repairs to boilers, etc., etc.

A gas pipe joint which has been recently developed abroad and is giving good service, is called "Stewart's patent long sleeve welded joint." This is made by tapering slightly the spigot end of one pipe, which is a driving fit, into a correspondingly tapered socket or sleeve on the next; the latter having a slightly belled mouth on which the welded joint is made. The close fit of the two tapered surfaces has the effect of relieving the actual weld of transverse bending stresses. The belled mouth serves a two-fold purpose—first, of facilitating the entry of the spigot end of one pipe into the socket end of the next: second—of affording a long contact surface for the weld.

In conclusion, it may be conservatively stated that the flexibility of the blowpipe is such that there are an infinite number of uses for it in almost every plant where iron and steel structural work or machinery is dealt with.

A committee of the Town Council of Berlin is investiagting a project for the construction of a tunnel for the use of street cars under the city's most fashionable street, "Unter den Linden." The carrying out of the project would relieve a growing congestion and greatly improve the appearance of the important thoroughfare. The tunnel would have parallel eastern and western sections, one northern entrance for four lines and two southern entrances for two lines each.

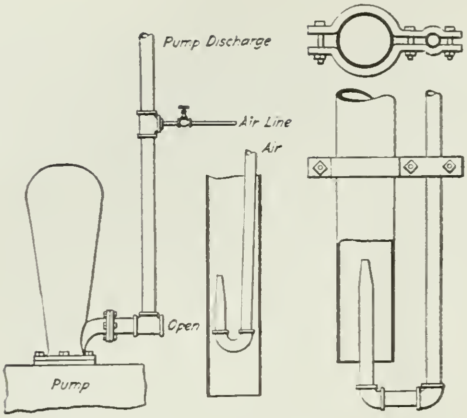


FIG. 1. FIG 2. FIG 3.

THE AIR LIFT FOR SHAFT UNWATERING

BY ARTHUR O. CHRISTENSEN.

A shaft can usually be unwatered more quickly and cheaply with an air lift than with pumps. It is therefore advisable, before allowing a mine to flood, to connect the air line to the discharge of the pump line as near the bottom of the shaft as possible, preferably a few feet above the pump, as indicated in Fig. 1. If there is a tee where the line joins the pump this should be left open. If there is not a tee the line should be disconnected from the pump.

To start unwatering, compressed air is simply turned into the air line and the pump discharge line begins to work as an air lift. The diameter of the air line where connected to the water pipe should be about one-fourth of the latter.

Even if the pump is one which can be started while drowned, so that an air lift attachment seems unnecessary, still it is desirable to have the connection made as described, for there is no knowing how long the pump may be submerged or whether it will work when the air supply is turned on. In such a case, however, it is not necessary to make any opening in the discharge line, since, if the air lift is to operate without the pump, it can suck water through the pump valves. Both lift and pump can be used, one helping the other. The air lift relieves the pump of a portion of its work by diminishing the head in the discharge, or, looking at it from the opposite standpoint, the pump aids the lift by supplying its suction end with water at a pressure which may be greater and cannot be less than would be the case were the pump not to act. Conversely if it is found that a pump is not able to lift its water to the point of discharge, the suction end being all right, a small amount of air admitted to the discharge line just above the pump will cause it at once to speed up.

In most cases, however, it is too much to expect a retiring management to leave a mine in such shape that it is necessary only to start up the compressor in order to unwater the property. The question is how to unwater the shaft as it stands.

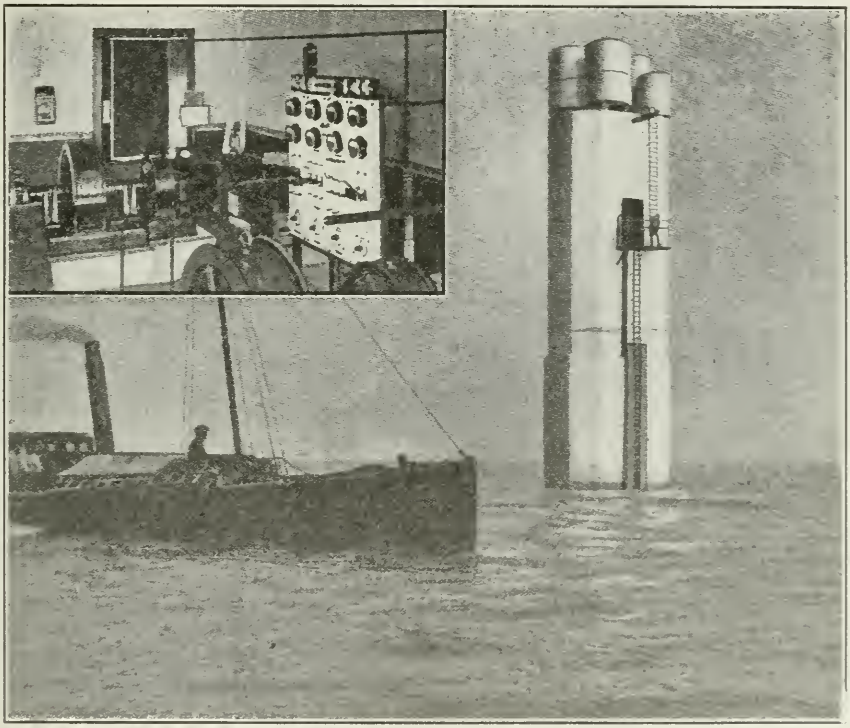
Frequently there is a pipe line running straight down the shaft. Whether the bottom of this be open or closed, and whether there be a pump attached or not, the air lift can be operated, so long as the line is straight enough to allow a pipe to be run down the inside. Fig. 2 represents the lower end of the inner pipe. If no return elbow is at hand, two elbows connected by a close nipple will answer. The nozzle is made by heating one end of a short pipe and forging it down to about three-fourths or one-half its original diameter. This arrangement can suck water through a drowned pump, although of course not so readily as if there were no obstruction.

Where a suitable pipe is in the shaft but is closed by a valve or otherwise, a charge of dynamite can be lowered by a small pipe within the larger, and the charge exploded by electricity—one ordinary dry cell will set off an exploder—thus breaking the pipe. The saving by using an air lift for the job is assumed to be more than the cost of repairs to the pipe line later on.

In case no suitable pipe for the water discharge is found in the shaft, a simple air lift can be dropped down a vertical shaft or can be lowered in an inclined shaft either on the truck or simply on a plank laid across the rails.

A 2 in. and a 1 in. line make a convenient size for such a lift, as is shown in Fig. 3. At intervals of from 15 to 30 ft. the two lines are strapped together as indicated. This arrangement will operate either vertically or on an incline. The discharge can be carried through elbows, but two 45° elbows give better resnlts than a single 90°. As soon as it is noticed that the ratio of water to air being discharged has decreased considerably, the lift must be submerged more, or, if this is not possible, the height of its discharge must be diminished by installing a pump as near the water as possible to throw the water from the lift to the surface.

With 100 lb. of air pressure, such a lift as indicated can raise water 200 ft. with a 20-ft submergence, or can lift 50 ft. with almost no submergence at all. The air issuing from the nozzle serves as an ejector to suck up and carry the water along with it. Air lifts can be compounded to raise water any heights with any submergence, down to almost nothing, but in general a pump is preferable to such a complicated arrangement.—*Eng. and Min. Journal.*



LIGHTHOUSE OPERATED FROM THE SHORE.

A LIGHTHOUSE WITHOUT ATTENDANTS

BY H. J. SHEPSTONE.

The only unattended lighthouse built on a wave-washed rock, boasting of a powerful fog signal and all the apparatus associated with a fully equipped light station is the recently completed Platte Fougère tower, marking the entrance to Russell Channel, which leads to St. Peter's Port, the capital of the island of Guernsey, in the English Channel. The tower guards dangerous reefs which have for years been a menace to shipping, more particularly in foggy weather than at night. The tidal currents and the great rise and fall of the tide, with its swing of 30 feet at this spot, also make navigation extremely difficult.

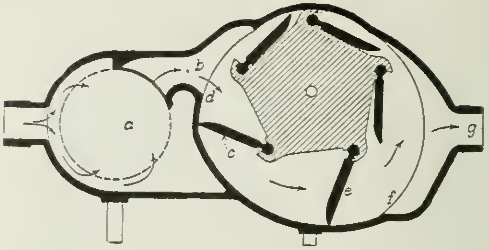
The possibility of erecting a stone tower to accommodate keepers was soon found to be out of the question, not only owing to the great cost that would be involved in constructing a rock lighthouse that men could live in, but also on account of the small area of the rocks. The difficulty was overcome by equipping one of the rocks with an 80-foot tower large enough to hold motors, compressors, fog horn and light, which are all controlled by a submarine cable from the shore. This lighthouse, with its wonderful array of electrical devices for warning and guiding the mariner through the dangerous channel, rises from a rock known as Platte Fougère, always submerged except at low water.

On the entrance level is a compartment containing an electric motor and air-compressor, while on the floor immediately above is a duplicate installation. The syren projects through the top of the tower, the trumpet being so turned as to throw the sounds in a horizontal direction over the water. On the top of the tower is a small automatic acetylene gas plant and lamps. All these devices, many of which are the invention of Mr. E. C. Catford, are controlled from the shore station, 1¼ miles distant, by means of a submarine cable specially made for this work. In fog it is desirable to know that both light and fog signal are working satisfactorily. Accordingly Mr. Catford designed special alarms which would inform him of their behavior. At a distance of some 15 feet from the lantern he placed a selenium cell electrically connected with an alarm bell in the shore station. So long as the light flashes every ten seconds on the cell the bell does not ring, but should fog obscure the light or the light go out for any reason, the bell at once commences to ring, thus giving the alarm. In the same way a bell rings in the engine room at every blast of the syren. The signal comes instantaneously, the actual sound of the blast itself reaching the shore five seconds later.

The shore station is situated at a point known as Doyle Fort. Here a dwelling has been erected for the keepers, adjoining which is the engine house. The machinery includes two oil-engines which drive three-phase alternators, and an air-compressor for working the land syren should that be required. In the tower itself there is a simple switch operated by an electro-magnet, whereby motor-driven air-compressors are thrown in and out of action. Thus, at night the light can be automatically turned on, and at sunrise automatically extinguished. In the same way the fog signal can be set in motion or be discontinued at will.—*Scientific American.*

A VOLUMETRIC AIR METER

The cut shows the essential features of a volumetric compressed air meter made by the Kreutzberg Meter Company, Chicago, Ill., for measuring and recording the actual volumes of air, regardless of the pressure of it, which may be flowing through a pipe at any given time. It may be connected into a service pipe anywhere the same as a stop-valve, a check valve or any other fitting and then as the air flows through the pipe its record will be made. Its handiness for observing the consumption of a rock drill, a pneumatic hammer or any other tool when in use will be appreciated. The meter should be used only in a horizontal pipe and the axis of the drum should also be horizontal, and if free air consumption is to be ascertained for any purpose, a recording pressure gage also would be essential.



VOLUMETRIC AIR METER.

Referring to the cut, the air enters on the left, passes into the screened chamber *a*, and from there it passes into the body of the meter through the passage *b*. It impinges against the vane *c*, causing the drum to rotate. When this vane has passed the point *d* a fixed volume of air is contained between vanes *c* and *c*. As soon as the latter reaches the outlet *f* the air is free to pass out into the pipe line at *g*, the contact of the lip of the drum with the case preventing it from following the drum any further. A counting train is connected to the drum spindle. The amount of energy required to rotate the drum must be quite small, and if the apparatus is carefully fitted to begin with there should be very little leakage. The meter is made of bronze throughout and normally is good for any pressure up to 150 lb.

CARBON DIOXIDE AND THE CRITICAL PHENOMENA OF GASES

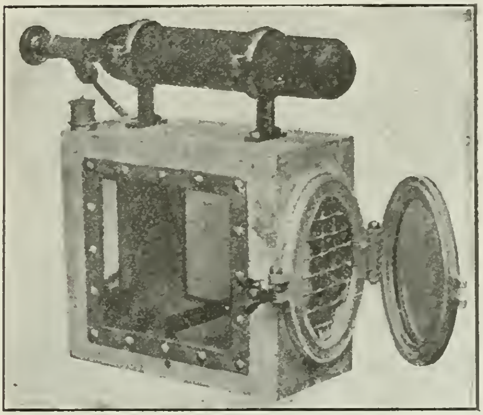
Carbon dioxide is a colorless gas, which possesses a faint taste and odor. It may be liquefied relatively easily, since it boils at—80° under atmospheric pressure. The critical temperature is 31.1° and the critical pressure is 73 atmospheres. The volume of one mole of carbon dioxide at the critical temperature and pressure is 95 cc., and is known as the critical volume of this substance. The critical phenomena were first studied in the case of this gas. There is a fundamental difference between a gaseous substance at temperatures above and below its critical temperature. In the former case, the substance remains a gas, no matter how great the pressure to which it is subjected. The density of the highly compressed gas may thus be made even greater than that of the subsfance in the liquid state at lower temperatures. If the temperature is at or below the critical value, we have seen that increasing pressure results in the partial or complete conversion of the gaseous substance to a liquid. The pressure which just suffices to produce liquid is definite for each temperature, being greatest for the critical temperature, and progressively lower for lower temperatures. This fundamental difference is expressed in the names gas and vapor. A gas is a gaseous substance above its critical temperature, and a vapor is a gaseous substance below its critical temperature. Thus, at ordinary temperatures and even up to 31°, carbon dioxide is a vapor. At higher temperatures it is a true gas.

Carbon dioxide is an important article of commerce, being used principally for carbonating beverages. The annual production in the United States is over 10,000 tons. It is marketed in the liquid state, in strong steel cylinders, since the pressure of the vapor in equilibrium with the liquid at ordinary temperatures is about 1,000 pounds per square inch. Carbonated water is prepared by dissolving (saturating) water with the gas under a pressure of about 225 pounds per square inch. When this water is drawn off, part of the gas escapes, since the pressure is reduced, and causes the liquid to effervesce.

If liquid carbon dioxide is exposed to the air in open vessels it boils vigorously. The heat necessary to cause the change from liquid to vapor (the heat of vaporization) is absorbed largely from the liquid itself. After this cooling has lowered the temperature to—78.2°. the liquid which remains is converted into solid carbon dioxide. The solid then continues to evaporate without first melting, i. e., it sublimes. It is, therefore, not possible to keep liquid carbon dioxide in open vessels, as the change to solid ensues. If the pressure on solid carbon dioxide is increased, it is found to melt at about—57° C.

Liquid carbon dioxide is a colorless liquid, which is only slightly soluble in water. It is characterized by a very high coefficient of expansion, showing greater changes of volume with changes of temperature than any other known substance. The coefficient of expansion of liquid carbon dioxide is greater even than that of gases.

Solid carbon dioxide is a white solid, which, as we have seen, sublimes at—78.2°. If the pressure of the vapor above it is reduced, it sublimes at still lower temperatures, and by causing the sublimation to proceed in a good vacuum, temperatures as low as—100° can be reached. A mixture of solid carbon dioxide and ether (the latter being used to effect good contact with the object to be cooled) is called "Thilorier's mixture," after its discoverer. It is used for obtaining temperatures down to the subliming point of the solid carbon dioxide (i. e., to—78.2°.)—*National Laundry Journal.*



CANARY AMBULANCE.

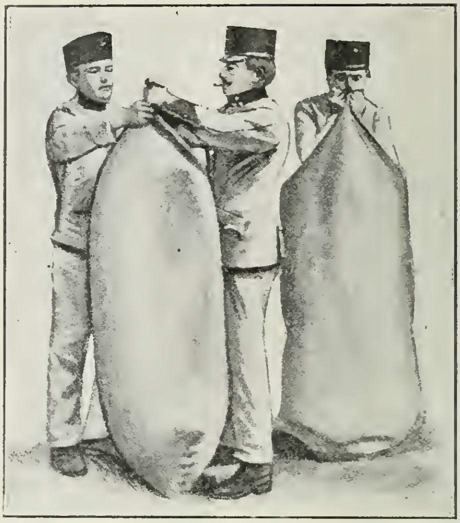
A PORTABLE ANIMAL REVIVER

Canaries and mice, as our readers know, are now frequently carried by miners where there is reason to suspect the presence of carbon monoxide or other dangerous gases. When a bird is overcome, thus giving timely warning to the men, it is not pleasant to think that that is to be the last of it, unless it is immediately carried out to where the air is pure. It might also be desirable to use the bird-test over and over again within a short space of time as different parts of the mine were traversed, and so the cage here shown has been devised for reviving the bird by the use of oxygen.

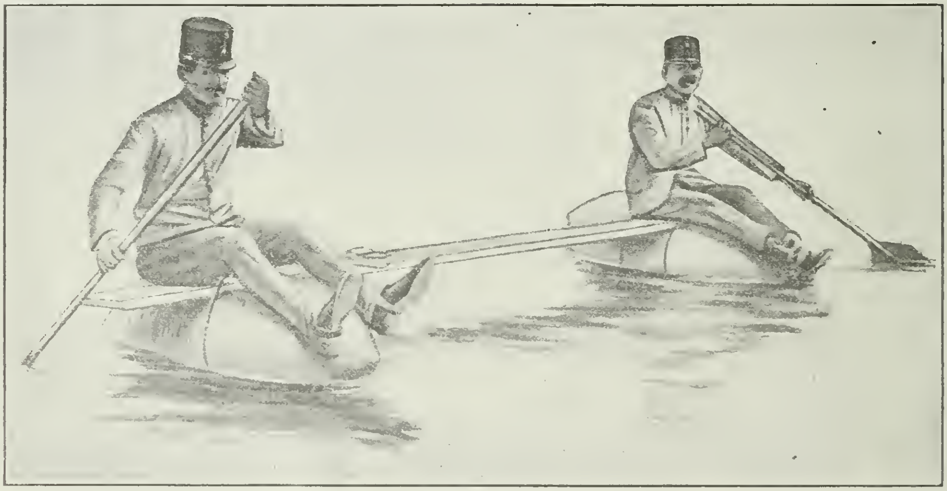
The cage is made of metal and it has glass windows on three sides of it. In front is an oval opening with a coarse wire netting and a tight-closing door. Above the cage is a cylinder containing oxygen under pressure, this cylinder also being utilized as a handle. When the door is closed a little oxygen admitted to the chamber restores the air to breathable condition and the bird revives. An outwardly opening valve at the top prevents any excess of pressure within the chamber. The cage is made by Siebe, Gorman & Co., London. H. N. Elmer, 1140 Monadnack Block, Chicago, is the American agent.

SOME BLOWERS IN THE AUSTRIAN ARMY

The engineer corps of the Austrian Army carry air bags which can be used in place of boats or as pontoons for emergency bridges. The bags made of waterproof canvas, are about 5 ft. long and half as wide and for transportation form a compact roll. When wanted for use they are unrolled and blown full of air the orifice then being closed and secured by a clamp. A plank 10 or 12 ft. long lashed to two of the bags will support several men. Spaced at proper intervals with suitable planks they form a serviceable bridge. The half tones on this page are reproduced from Popular Mechanics.



BLOWING UP THE BAGS.



USED AS A RAFT.

ANIMAL INTERRUPTERS

The earwig which held up the London District Railway service recently, by short-circuiting the electric-signalling apparatus, was unwittingly emulating the spider which on June 4th, 1908, dislocated the traffic on the Irish Great Northern Railway for nearly two hours. The electric staff instrument failed, and ultimately the cause was traced to a spider which had lodged itself between the lever and the contact points. Last year a train was derailed on the London and North-Western Railway owing to a hedgehog having been caught between the point and side rails and preventing them closing properly. A Mississippi steamer was recently stopped by an invasion of willow-bugs, which made for the engine-room and clogged the engines, while a swarm of bees in December, 1912, took possession of a South African railway station, drove off the passengers and officials, and prevented any trains entering until they took their leave in the evening.—*The Engineer.*

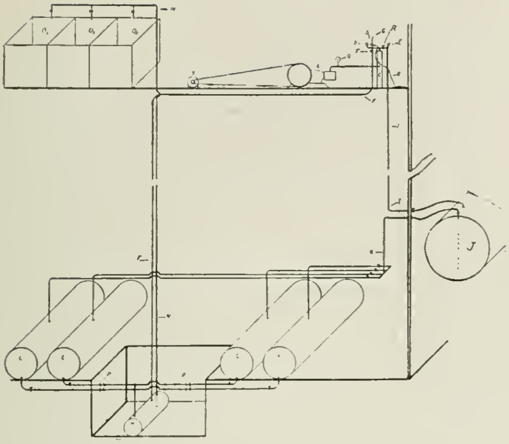


FIG. I.

HANDLING CHEMICAL SOLUTIONS IN QUANTITIES

BY C. C. PHELPS

When acids and other chemical solutions of a corrosive nature must be lifted or conveyed from one place to another, the relative advantages of different methods of accomplishing the desired result cannot be decided on the questions of initial or operating costs alone, for the service may be so severe on certain types of apparatus as to render them practically useless in a short time. Frequent delays for repairing may also occasion great losses due to the stoppage of manufacturing processes. Ordinary reciprocating and rotary pumps are often out of the question, even when constructed of special material of a non-corrodible nature.

A device known as a montejus, which is operated by either air or steam pressure, has been used to some extent for this purpose and is fairly satisfactory; but it is open to the objection that it has valves, floats and other moving parts in contact with the fluid. Other devices, using air or steam pressure, employ either the injector or siphon principle for their operation with more or less success, depending upon the requirements, but they, too, have certain limitations in practical use.

For handling chemical fluids in large quantities the method illustrated herewith has certain advantages which will be apparent from the description. The system illustrated in Fig. 1 is in use in a large Massachusetts textile mill, for raising heavy commercial oil of vitriol to bleaching vats on the third floor of a building. Compressed air is used, not only for this purpose but also to empty the acid from the tank cars which are brought alongside of the building. The engineers in charge of this plant consider that the method which they have adopted is admirably adapted for its purpose.

Referring to the diagram, O_1, O_2, O_3 are lead-lined bleaching vats; they are partially filled with pure water, after which 100 gal. of the concentrated sulphuric acid is raised and added slowly to the water, the contents being stirred while the acid is being added; then a small quantity of hydrochloric acid is added by hand from a carboy, after which the bleaching solution is ready for use.

Located near the vats is an air compressor *A* driven by a 2½-hp. belted motor *B*. The compressor cylinder has a displacement of 15 cu. ft. of free air per minute and operates normally at 40 lb. per square inch air pressure. The compressor, gauge, receiver and controlling valves are shown in the photographic view, Fig. 2.

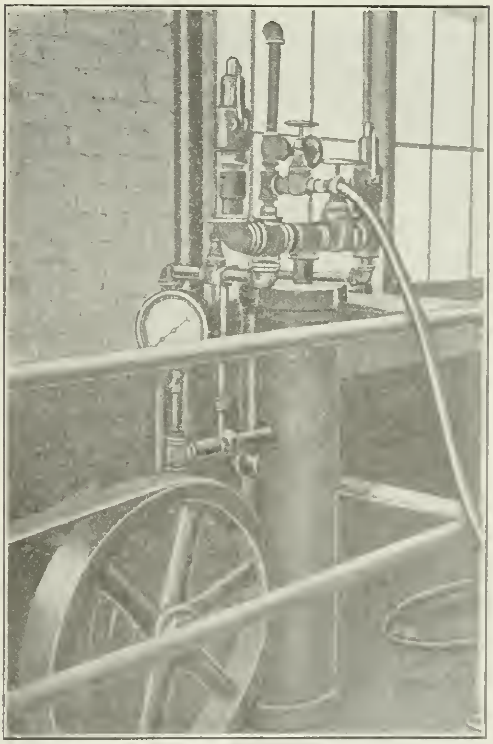


FIG. 2.

The compressor discharges into a length of pipe *C* of large diameter, which acts as a receiver to steady the pressure in the line. Gauge *Q* indicates the air pressure in the line. Two air lines. *I* and *F* lead from the receiver. By closing all valves on the left of the receiver outlet and opening valve *R*, pressure is put on pipe line *I*. The latter line leads to a connection whereby air pressure can be put on the tank of an acid car *J*. Safety valve *E* is set for 15 lb. per square inch, so no pressure in excess of this amount can be put on the car tank. The car tank's outlet is coupled with pipe *K* leading from the outside of the building to four heavy iron reservoir tanks *L* in the basement of the mill. Each of the tanks *L* has a capacity of 3,500 gal. and is provided with air vents. With an air pressure of 15 lb., it requires about two hours to empty the car, capacity of which is usually about 5,000 gal.

Pipes lead from the bottom of the reservoir tanks to the top of a 100-gal. iron supply tank *M* placed a few feet below. In each of these connecting pipes is a check valve *P* to prevent the acid from returning to the large tanks. Leading from the top of the small tank is the air pipe *F*. Normally this serves as a vent, allowing the acid to flow into the small tank and fill it. When a charge of acid is wanted, this vent is closed by a valve *S* near its outlet *G* and air pressure is put on this line by opening valve *T*. The acid immediately begins to flow from the bottom of the 100-gal. tank up pipe *N* to the bleaching vat, a height of about 40 feet. About five minutes is required ordinarily to pump the 100 gal. with an air pressure of 40 lb. Safety valve *D* is set for 50 lb. A short length of hose *H*, connected to the air system, is used for cleaning and similar purposes.

With this system there is no mechanism to come in contact with the acid and get out of order. When a charge of acid is wanted, the motor is started by simply throwing over the starting switch, and then the proper valves are opened. The charging tank will not deliver more than a hundred gallons at a time, although less than that quantity could easily be obtained by shutting the valve at the vat at the proper time. The air pressure on the tank being constant the rate of acid flow will be constant, and the quantity of acid lifted in a given time will be proportional to the time required for raising it. Pressure is put on the line only when actually pumping, hence the economy of operation is evident The air pressure is on only the small tank and the lines leading to and from it. The larger tanks are never under air pressure, and hence any trouble that might develop through leakage in such large tanks is avoided. The acid, being in concentrated form. does not cause any trouble from corrosion in the iron tanks or pipes, as might occur with dilute acid.

The flow of acid by gravity from the reservoirs to the small tank is entirely automatic, and reversal cannot occur. No attention is given to the apparatus in the basement, the entire control being where the acid is used. The extreme simplicity of the arrangement described should suggest its use for a large number of industrial processes, perhaps with modifications to suit each case. *Metallurgical and Chemical Engineering.*

SPECIFICATIONS RELATING TO COMPRESSED AIR IN TUNNEL WORK

The construction of additional subway tunnels under the East River. New York, has required the preparation of specifications covering the new contracts. These are very comprehensive and specific and embody details of requirement suggested by the latest experiences in similar work. The requirements relating to the use of compressed air and the safety of the workers under pressure are much extended, and embody important requirements beyond those found in existing laws. These, it is understood, were specially prepared by Mr. Frederick C. Noble, division engineer.

There are nearly two miles of double lines of single track tunnel excavation under compressed air. most of it shield work with cast iron lining. A large portion of the work is in sand at a maximum depth of 90 ft. below mean high water.

The first requirements are as to the sufficiency and the reliability of the mechanical equipment. The contractor must install air compression, hydraulic and electrical machinery, hoists, pumps and all other necessary apparatus of the highest grade in use for the work to be performed and having a capacity sufficient to meet not only unusual conditions but emergencies, and to afford a margin for repairs at all times. Provision must be made for storing in tanks at the boiler house enough feed water for twelve hours' supply, unless connections can be made with two independent and separately sufficient sources of supply. If electricity is used for operating compressors supplying air to the tunnel headings, the supply cables shall be in separate lines and shall each connect, if possible, with two independent and separately sufficient sources of current.

The compressors shall be capable of furnishing simultaneously to each heading an air supply sufficient in volume and pressure to enable work to be done as nearly as possible in the dry, and to afford the specified degree of ventilation. At each heading where the shield is used the air supply pressure of 45 lb. per square inch above atmospheric pressure must equal at least 10,000 cu. ft. of free air per minute as measured by piston displacement, unless both tunnels are operated from the same compressor plant, when this air supply may be reduced to 8,000 cu. ft. of free air per minute. The plant, in addition, must be capable of furnishing to all parts of the work a sufficient air supply at a pressure of 100 lb. or more if required for operating drills, grouting machinery and other pneumatic tools. The air for the compressors shall be drawn from pure outside sources and protected from fouling by lubricating oil.

The compressor revolutions shall be registered by mechanical counters, and the pressure in the air receiver shall be continuously registered. Cooling apparatus shall be provided to maintain the temperature of the air in the tunnels and caissons always at a moderate degree. All buildings for the compressor plant and in the immediate vicinity shall be as nearly as practicable fireproof and all reasonable precautions shall be taken to prevent and extinguish fires. A water line shall be extended into each heading, 200 ft. of hose, and nozzle connections shall be maintained ready for constant use at each bulkhead and no lighted candles or matches will be allowed near roof timbering in compressed air.

MEDICAL AND SANITARY RULES

The workmen's quarters shall be well lighted, heated and adequately provided with running hot and cold water, showers, lockers and facilities for resting, for drying clothing, and for providing hot coffee. Care shall be taken to keep all parts of the tunnel in a thoroughly sanitary condition and free from refuse or decaying matter. There shall always be on duty a competent physician and surgeon experienced in the treatment of the physiological effects of compressed air, and he shall care for the health of the employees and supply treatment and medicines to them whenever needed.

There shall be maintained in close proximity to the shaft at each side of the river a completely equipped hospital room with an attendant constantly in charge. Each hospital room shall include in its equipment a commodious hospital lock in two compartments, where men can be subjected to the regular working pressure if attacked by caisson disease. Such locks shall contain cots, a telephone, air gage, and arrangements for ventilating and heating. Provisions shall be made for the immediate removal and hospital treatment of any employee who may be injured or become ill. No person shall be employed in compressed air until after passing a satisfactory medical examination, and any employee absent for ten or more successive days shall be re-examined before being permitted to resume work in compressed air.

All reasonable facilities shall be afforded for the investigation of the physiological effect of compressed air, including the conduct of experiments and the collection of records in connection therewith, to be undertaken by such scientific bodies of individuals as may be designated for the purpose by the commission.

AIR CHAMBERS

Air chambers shall be formed in the tunnels by brick, concrete or steel plate bulkheads of sufficient strength to safely resist a pressure of 15 lb. per square inch. Whenever the air pressure in the heading exceeds 22 lb. per square inch above atmospheric pressure, two air chambers shall always be in use, except when headings are being started from shafts, and the pressure in the outer one shall not exceed one-half the pressure in the heading. The distance from the heading to the nearest bulkhead shall not exceed 800 ft. during the progress of the work.

Three metal airlocks are to be firmly set and anchored in each bulkhead. These shall consist of two main locks not less than 6 ft. in diameter, heated and ventilated if required, and an emergency lock not less than 5 ft. in diameter, which shall be located as high up from the bulkhead as practicable and shall be large enough to hold an entire heading shift. When not occupied the emergency lock shall be kept open toward the heading and ready for instant use at all times. Lock doors must operate easily. A heavy glass bull's-eye must be set in each end of each lock.

Air valves must be arranged to be controlled from inside the lock. One of the main locks shall be connected to the main air line so that it may be locked from outside. Each lock shall be provided with an air gage and a clock. An 8½-in. air gage shall be placed in an accessible position on the outer side of each bulkhead. A recording air gage shall be placed on each main and shall be locked and the key kept by the engineer. A lock tender shall be on duty at all times at each lock bulkhead. A watchman shall be on duty at all times in the heading and when for any reason the work is suspended.

SAFETY SCREEN

In each heading chamber, when the same extends beyond the river bulkhead line, there shall be provided a safety screen extending from the springing line of the tube to the track. It shall be made of substantially braced steel plates with airtight joints. It shall be moved forward as the work progresses so as never to be more than 115 ft. in the rear of the shield. In each heading chamber, when the same extends beyond the bulkhead line, the contractor shall provide about the middle of the height of the tunnel a substantial runway, at least 3 ft. wide, leading from the shield platform to a platform at the emergency lock. The runway shall be provided with a handrail and steps or ladders at frequent intervals for access from the track level. A telephone connection shall be maintained in service from each heading and each lock to the power house and to the office of the commission's engineer corps near the shaft.

The air supply through the shaft and tunnel in each heading shall be through two pipes, each at least 10 in. in diameter, with sufficient capacity to prevent excessive drop in pressure in regular working. Each supply pipe shall be provided with a pressure-regulating valve in each air chamber and with suitable valves arranged for by-passing at a convenient point between the power house and the shaft. Special devices shall be used to deaden the noise of air supplied or exhausted.

The supply of fresh air shall be sufficient to permit work without danger or discomfort, and where work is in compressed air such supply shall be sufficient at all times and places to prevent the accumulation of carbon dioxide to a greater amount than one part in one thousand by volume. A foul-air vent pipe 6 in. in diameter shall be carried back from each heading under pressure to the ordinary atmosphere and shall be provided with a suitable regulating valve so placed as not to be readily tampered with. The compressors must be so run as to maintain at all times a change of air through the regulating valves. Special means must be provided for the rapid removal of blasting fumes.

THRILLING SUBMARINE EXPERIENCE

The following account of the unparalleled experiences of the Russian submarine Mingoa comes to us through a correspondent of the *Railway and Marine News,* Seattle:

Water leaked through a defective ventilator until the trim of the submarine was affected and she plunged head foremost to the bottom. Owing to a series of unfortunate delays the vessel was not brought to the surface until nine hours after her disappearance. When the after-hatch was opened three men staggered out, barely able to crawl. Fifteen of the crew and the captain were got out unconscious from the after-part of the vessel. There remained only the coxswain, who was in the conning tower amidships. It was necessary to raise the submarine well out of the water to get at the conning tower, and this took another three hours' work, but the coxswain, when released after twelve hours' confinement, was in the best condition of any of the crew. Water had continued to enter until the air in the vessel was so far compressed as to resist the entrance of any more. On this air the crew of twenty survived, the captain and fifteen men in the body of the vessel suffering also from the fumes of chlorin gas given off by the accumulators. The three men who crawled out unaided from the after-hatch, and the coxswain who, after being confined in the conning tower three hours longer than any of the mates, was yet the least affected, were apparently out of reach of the chlorin gas fumes. All have now recovered from the effects of their terrible experience.

The usefulness of the emergency buoy, which is also employed in the French submarine service, is amply demonstrated by the Mingoa accident. But the success of the rescue, after all, depended mainly on the "natural" factors of the case; the favorable weather conditions, and, above all, the fact that the accident took place in comparatively shallow waters. Had the depth been twice or thrice the seven fathoms of the Mingoa—and submarines exercise at great depths—the balance between the pressure of the water and the compressibility of the air contained in the vessel would have been against the probability of the survival of any of the crew, while the enormously increased difficulties of salvage with increased depth would likewise have been all against the liklihood of saving life.

ELLIOTT CRESSON GOLD MEDAL AWARDS

The Franklin Institute has awarded its Elliott Cresson Gold Medal, the highest award in its gift, to the following:

Prof. Karl Paul Gottfried Linde, Ph. D., in recognition of his scientific investigations of the processes of refrigeration and the liquefaction of gases and of his inventions of machinery for applying these processes in the manufacture of ice and for the purposes of cold storage.

Prof. Edgar Fahs Smith, Ph. D., Sc. D., LL. D., in recognition of his leading work in the field of electro-chemistry, of his many contributions to the literature of chemical science, and of his great service in university education.

Joseph Maria Eder, Ph. D., in recognition of his important original researches in the science of photo-chemistry and of his many valuable contributions to the literature of that science and of the graphic arts.

Orville Wright, B. S., LL. D., in recognition of the epoch-making work accomplished by him, at first together with his brother Wilbur and latterly alone, in establishing on a practical basis the science and art of aviation.

KARL PAUL GOTTFRIED LINDE

The following is a brief sketch of the life of Professor Linde as given out by the Franklin Institute in connection with its award of the Cresson Gold Medal.

Karl Paul Gottfried Linde, Ph. D., was born in Berndorf, Oberfranken, on June 11, 1842. From 1866 to 1868 he was director of the construction department of Krauss & Co.'s Locomotive Works, Munich, Bavaria. In 1868 he was appointed assistant professor at the Technical High School, Munich, and three years later professor. From 1879 to 1890 he was manager of the Linde Ice Machine Company.

He was the pioneer in the manufacture of ice on a large scale, and in the introduction of liquid ammonia as the refrigerant in ice machines and cold storage systems. The refrigerating machinery mostly used at the present time, known as the ammonia "compression" system, is essentially Linde's invention. In applying the principle of self-intensive refrigeration, i. e., by utilizing the cold produced by allowing compressed air to expand, Prof. Linde was the first one to liquefy gases like air without the use of other liquefied gases and on a large scale. He also devised an ingenious process for the fractional liquefaction of air by which the bulk of the commercial oxygen is now manufactured. Thus the life work of this great engineer and inventor includes at least three achievements of the first magnitude:—The invention of the almost universally used liquid ammonia ice machine; the construction of the first and most successful liquid air machines and the devising of the process of making oxygen by its liquefaction from atmospheric air.

PNEUMATIC RIVETERS AND RIVETING CONDITIONS IN STRUCTURAL WORK

The field connections in the lower seven stories of the Equitable Building, New York City, are very largely made with 1⅛-in. rivets, of grip up to about 9 in. It has been found that to drive these rivets successfully the largest obtainable pneumatic hammers are required, and air pressures up to 110 lb. must be used. Further, it is important that the point of the rivet be no hotter than the shank under the head, and in some cases the rivets are cooled at the point by dipping into water.

In the early stages of the work, a rather heavy percentage of rivets was condemned by the inspector, in some cases because not enough stock had been left for the heading up. As these rivets are now being used a length of 2⅛in. is allowed over the grip to form the head and to supply metal for the upset. This allowance is somewhat excessive, but it gives a safe margin to allow for any overrun in the size of hole, etc.

Practically all the field-connection holes are reamed out after assemblying, in spite of the fact that they are already drilled holes. The reaming insures a perfect match and guards against difficulty in entering the hot rivet.

The hammers used are long-stroke Boyer and Ingersoll-Rand $1^{13}/_{64}$x8-in. hammers.

The experience of the riveting gangs of the Thompson-Starrett Co. as stated by the boss of riveters, is that about 50% more ⅞-in. rivets, or about 75% more ¾-in. rivets could be driven in the time required for a given number of 1⅛-in. rivets. This, as will be seen, means that the 1⅛ in. rivets do not cost more per sq. in. to drive than rivets of smaller size.—*Engineering News.*

THE DIESEL ENGINE

The following concise statement of the essential features of the Diesel engine we take from a paper by J. T. Milton before the Institution of Naval Architects.

Diesel engines are broadly divided into two classes, namely, the two-stroke and the four-stroke. In both types a cylinderful of air at atmospheric pressure is compressed by the piston at the top center till its pressure becomes about 500 pounds per square inch. The compression raises its temperature to about 1,000 degrees F. At this instant a small quantity of oil fuel is blown into the very hot high-pressure air by means of a blast of air at still higher pressure. The oil is broken into a fine spray and its admission lasts only for one-tenth of the downward stroke. During this short time much of the oil is burned in the hot air. The aim is that the combustion shall proceed at the critical rate which shall permit the increase of volume occupied due to the motion of the piston and the increase of temperature to be so balanced that the pressure will remain constant until all of the oil has been burned. After this the expansion of the hot gas will still further push the piston down and the pressure will rapidly decrease. The maximum temperatures actually obtained in the cylinders are very high, approximating in some cases nearly 3,000 degrees F. It is these exceedingly high temperatures which occasion much of the special difficulties of Diesel engines, and it is necessary to keep the rubbing surface of the metal exposed to the hot gases sufficiently cool to permit of their retaining their lubrication; it is also necessary to prevent all the metal with which the heat comes in contact from becoming so overheated as to impair its strain-resisting properties.

ATMOSPHERICS

From the London Spectator

(Atmospherics, or "X's," are the sounds caused by atmospheric electricity. They are particularly strong at night, and they frequently interrupt wireless messages).

There's a little green devil that sits all the day
Up aloft with his feet on aerial wires:
He's booked for the day and has to obey,
But I guess he would like to get back to the fires—
Yes, I'm sure he would like to get back to his fires.
It's all right in the day with the sun shining strong,
But at night, to keep warm, he will dance on the wires,
And then—atmospherics start coming along!
The X's, the X's,
Oh, bother the X's!
For that's when the X's start coming along!

You've picked up a ship at the deuce of a range,
Or you're taking the news and can only just hear,
And the devil gets cramped and decides on a change—
Stands up, swings his arms, thinks of you with a jeer!
Shuffles down, prances up, heel and toe—(with a jeer)!
And begins his own dance to his own little song,
And there's not a word more of your message you'll hear—
For now atmospherics are coming along!
The X's, the X's,
Oh, bother the X's!
"Very strong atmospherics" are coming along.

He's fond of a hornpipe, and good at a jig,
A valse he calls "slow" and a minuet "old"—
For such stately dances he "don't care a fig."
What he wants is something to keep off the cold.
But oh! when the night is especially cold,
It's tango, plus cake walk, plus popular song!
It'll turn your hair gray, it'll make you grow old
When X's in ragtime start coming along!
There's nothing that vexes
So much as the X's,
When X's in ragtime start coming along!

JOHN ENGLISH.

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EVERYTHING PNEUMATIC
Established 1896

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NECESSARY REQUIREMENTS FOR WORK UNDER PRESSURE

The specifications relating to the use of compressed air in the additional subway tunnels to be driven under the East River, as printed elsewhere in our present issue, mark a distinct advance in compressed air practice, certainly in so far as the safety of the workers is concerned. As pointed out by Frank Richards first in *Engineering News* last year, the laws defining the conditions under which men are to be allowed to work in air under pressure have been peculiarly deficient in their provisions, in that they have referred to pressures alone, and have had nothing to say about the condition of the air furnished, or the systematic renewal of it while work is in progress and especially during the process of decompression.

It is a strange thing that those who have professionally investigated the phenomena of caisson disease, who have experimented with the purpose of developing the best modes of treatment, and have presented more or less elaborate reports upon the subject, have had little to say about any air condition except the pressure. It would seem that some of the reports which are accepted as authoritative should be rewritten with the insertion of data covering the necessity of constant renewal of the air and its maintenance at a certain standard of purity while work is in progress and during all the stages of decompression. It is not to be wondered at that the compilers of laws relating to work in compressed air have not gone farther in their requirements than these investigators have led them.

In these trying days of summer we, who are not subjected to any abnormal air pressure, are uncomfortably and even painfully affected by slight increases of atmospheric humidity. How much greater must be the baleful effect of increased air pressure when to that are added humidity changes, decreases of oxygen content and accessions of various noxious gases.

It is well when these matters are taken in hand by the great contracting companies without legal pressure. The specifications prepared by Mr. Noble are essentially good business and at the same time they are such that the lawmakers may take lessons from them and so shape their enactments that all air workers may be assured safe working conditions. The "sand hogs" are not always the best authority as to what is good for them, and are sometimes loath to accept and strictly comply with wise and proper regulations and it is well to have it all settled in a business way before beginning operations.

IMAGINARY "CAVES OF THE WINDS"

The *Saturday Evening Post*, we are assured, feels its responsibility and is usually careful as to the matters, little or big, which its puts before its millions of readers. Nevertheless it cannot be always correct, and the following, from a recent issue, is one of the instances wherein it is misleading. It says:

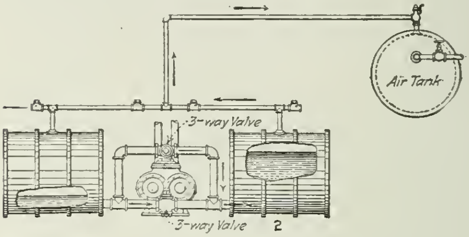
"At the great Anaconda Mines * * * an underground rock receiver was blasted out at the foot of a hill and compressed air is pumped into this receiver. Far up on the hill is a reservoir of water, with a pipe running down below the air receiver and coming up into it through the bottom. The water from the reservoir would naturally flow down into the air receiver, but the air pressure there keeps it out. When the stock of stored-up compressed air is reduced water comes up into the air receiver, and when an excessive amount of air is pumped in, the water in the hill reservoir rises; but the air pressure in the rock cavern always remains steady."

There is no such rock storage of compressed air at the Anaconda mines, but there is instead an imposing group of upright steel receivers connected together, a view of which has appeared in our pages. The constant air pressure is, however, maintained in the receivers by the head of water as described. We have repeatedly given accounts of the use of abandoned tunnels or other rock excavations for air receivers, but not at Anaconda Mines.

NEW BOOK

Safety and Efficiency in Mine Tunneling, by David W. Brunton and John A. Davis, Government Printing Office, Washington, D. C., 271 pages, 6 by 9 inches. Many illustrations.

This is to be regarded as one of the best—which is saying a great deal—of the many valuable publications of the Bureau of Mines. Why *mine* tunneling is specified in the title is not apparent, since water tunnels and railroad tunnels are perhaps more in evidence. Not only are the causes and modes of prevention of mine accidents fully discussed, but the entire field of tunnel construction is gone over with accounts of both the methods and the mechanical agencies employed. The book is conveniently practical and is based upon actual and reliable information. A great number of the most prominent tunnels were visited by the writers and all that has been written upon the subject seems to have been thoroughly gone over. A Bibliography relating to tunneling at the end of the book fills 27 pages.



AN EMERGENCY AIR COMPRESSOR

The sketch here reproduced from *Power* was contributed to that publication by Mr. F. W. Hudson, Ager, California; his rather meager description is as follows:

"We were in urgent need of a small air compressor. An idle steam pump and nearly all the fittings were at hand, so the pump was connected up as shown. Everyone was agreeably surprised at the results. Any air-tight receptacles, such as oil or plumbers' tanks may be used, but the greater the capacity of Nos. 1 and 2, the fewer the shifts of the three-way valves for a given quantity of air. The capacity of the compressor is equal to its displacement in gallons or cubic feet."

This arrangement might have done for an emergency, but is not to be thought of as an installation with any suggestion of permanence, and even in the emergency the water pump—with valves and pistons reasonably tight—would probably have pumped the air directly into the receiver quite as satisfactorily without all the paraphernalia here employed, the waste of power being great in either case. The manipulator of the three way valves probably would have also a lot of adjusting of the pump throttle, since the power required at the beginning of the filling of the tank with water, with no air pressure above it, would be very small as compared with that required when the tank was nearly full with the compressed air pressure on the water.

AIR PRESSURES IN PLAYING WIND INSTRUMENTS

In an interesting article in the *Philosophical Magazine,* Mr. Foord refers to Dr. Stone's table of wind pressures required to play various notes of the scale on various wind instruments. The table indicates that as the notes rise higher in the scale the air pressure necessary to produce them increases with most wind instruments, although not with all. In the clarinet, for example, the pressure decreases from the low notes to the high ones, varying from 15 inches of water to 8 inches. Mr. Foord repeated these experiments on the clarinet and saxaphone, playing the whole range of notes first loudly and then softly. For the clarinet it is found that the pressures fall as the notes rise, agreeing with Dr. Stone's table, although the inverse law holds good for the oboe, bassoon, horn, cornet, trumpet, euphonium, and bombardon.

With the saxophone it is found that the pressures corresponding to notes at the beginning and end of the register are equal, the pressure rising to a maximum at the note D about half-way through the scale.

TUG WITH AIR PROPELLER

What is styled by her builders an aerotug has been built by James Pollock Sons & Co., Ltd., London. This craft has a rectangular hull 30 by 10 feet, with square sides and bilges, and rounded up bow and stern. She draws about 8 inches of water and is designed for work in a river in Demerara, British Guiana, which has a maximum depth of only 13½ inches. The engine is a 15 horse-power single-cylinder Bolinder working on residual oil and coupled through a clutch to a spur wheel. A propeller revolving in the air instead of in the water accounts for her appellation. From the spur wheel a Hans Renold silent chain is laid vertically to a pinion on the aerial propeller shaft, which is geared up in the ratio of 450 to 1,200. The propeller shaft is carried in ball-bearings, which take both the pull of the chain and the thrust of the propeller, the bearings being mounted on a steel framework securely fixed and stayed to the framing of the tug. The propeller is 9 feet in diameter and the tug has a mean speed of 5 miles per hour, high speed being undesirable on account of the wash it would cause. The noise and vibration are considerable, but for the type of craft in which they are employed are of little importance. On the other hand, the boat seems to be a successful attempt to overcome the difficulty of navigation in shallow and weedy waters, and is capable of getting under way promptly. The propeller was designed and made by the Aero Propulsion Syndicate, Ltd., of Victoria street, Westminster.

DIFFERENT VIEWS OF MINING

Hazel, you see, her mineralogical lore being derived wholly from the movies, had never even heard of the sort of mine that was just a big, uncompromising mountain all seamed and fissured with streaks of green rock that had to be dug and blasted out of it—rock which, when ground and slimed and separated and roasted and smelted, produced copper and silver and lead and zinc and other uninteresting elements in varying proportions to the ton; of a mine that wanted money and patience and hard work, and then, insatiably, more money and more patience and more hard work, before it even began to yield up its treasure to you.

A mine, to Hazel, was a little pocket in the rock into which the thirst-parched and half-delirious prospector reached an emaciated arm and began pulling up irregular nuggets about the size of base balls, of pure twenty-four carat gold. The moment before you found it you were penniless—desperate. The moment after you found it you were rich beyond the dreams of a stage multimillionaire. One day you were perishing for a crust of bread—the next you were buying an automobile, a racing stable, and a palace on Fifth avenue.—*Saturday Evening Post.*

THE SECOND SIMPLON TUNNEL

The building of the second Simplon Tunnel has made such good progress, despite a serious strike and an attempt on the life of Chief Engineer Rothpletz, that the last stone in the high-pressure portion has already been laid. This portion of the tunnel, which is about 46 yards in length, is exactly co-terminous with and parallel to that which gave so much trouble in the first Simplon Tunnel. In 1901, when the borers of the first tunnel entered this part of the mountain, copious hot springs gushed out, making work for the time being impossible, and seven months were required to push the bore through these 46 yards, and eighteen months to complete and line this short length. Only five months, however, have been required for the same work over this portion in the second tunnel. But before it was begun the engineers went all through the high-pressure zone in the first, and strengthened it throughout with strong iron scaffolding.

THE DRILL SHARPENER AT SOUTH AFRICAN MINES

Even the smaller economies when reflected over the enormous tonnage handled by the mines of the Rand, mean large aggregate savings, and one direction in which investigation appears to be called for with a view to the reduction of costs is in regard to the sharpening of drill bits. The greater part of this work on the Witwatersrand is now performed by machines, and the saving, through the employment of mechanical appliances, as against hand-sharpening, is very large. From a reliable authority we understand that economy to the extent of something like 39s. per 1,000 steels handled results from drill sharpening by mechanical appliances, as against sharpening by hand. We learn that to-day about 80 per cent. of the bits employed in Main Reef mines are sharpened by hand, and this naturally leads up to an inquiry as to why all mines do not adopt the obviously more economical method. In other words if eight-tenths of the Rand's technical talent is of the opinion that the sharpening of drill bits by machine is more economical than by hand what reasons can the adherents to the more antiquated method adduce for their conservatism?—*South African Mining Journal.*

NOTES

Sun-motors being tried experimentally in Egypt require 250 square feet of sunshine per brake horsepower developed.

A New York contractor always wears a derby in tunnel work, because it acts as a bumper and often saves his head a knock in dark and crowded quarters.

The paper used by the U. S. Government printing office each year requires approximately 62,500 tons of rag pulp and 245,000 tons of wood pulp.

The world's present total production of fuel oils of all kinds is slightly less than 55,000,000 tons, of which 47,250,000 are petroleum oils; this is about 5 per cent. of the world's present coal output.

The Canadian Northern Railway had its beginning in 1896. For seventeen years it has averaged a mile of new line a day, and this year it will boast a complete transcontinental line from the Atlantic to the Pacific.

"Mr. R. C. Cole has joined the staff of the Pneumatic Tool Dept. of the Ingersoll-Rand Co., and has been stationed at the Chicago office."

In the state of Puebla a track cable weighing 29,000 lb. was carried to a mountain top in connecting coils of about 100 lb. each, by an army of peons. When mules are employed about 220 lb. is allowed to each mule.

In the Challenge district, California, the uncovering of gold quartz by ants led to the discovery of a rich pocket of gold. Attention was attracted to the place by traces of gold near the ants' nest.

Flying with a wind that was blowing at 62½ miles an hour, an aeroplane carrying two German military airmen recently made a flight from Hanover to Berlin, 160 miles, in almost exactly an hour.

Trials have been made in Germany to ascertain the possibility of using the oxy-acetylene torch for removing the scale in boilers. These are reported to have been successful. The deposit is immediately removed without injury to the plate.

The driest place in the world is said to be in Egypt betwee the two lower falls of the Nile. Rain was never known to fall and the inhabitants do not believe travelers who say that water can fall from the sky.

A cofferdam employed in building a bridge pier at South Norwalk, Conn., which collapsed with fatal results May 20 was spoken of in the daily papers as a pneumatic caisson. This was a mistake, as no compressed air was used.

The lowest point of dry land in the United States is less than 80 miles from the highest. The lowest point is in Death Valley and is 276 ft. below sea-level. It is said that from this point Mount Whitney, 14,501 ft. above sea-level, can be easily seen on a clear day.

It has been shown by the Bureau of Mines that electrical energy can be developed more cheaply in the Lousiana gas field by using the gas in gas engines, directly connected to electrical generators, than in the waterpower plants of Niagara.

Soon the farms will depend on the engineer, not only for the machines to work the soil and harvest the crops, but for the raw material, fertilizer, which combined, through the soil, with the germinating seed, produces the plant which is the basis of all food, either animal or vegetable.

An international tunnel said to be the only tunnel in North America to cross an international boundary line, is about to be started on the San Diego & Arizona Railway. Although the bore will be only 620 ft. long, one end will be in the United States and the other in Mexico.

The Caspian Sea which forms part of the boundary between Europe and Asia, 730 miles long and 150 to 270 miles wide, is slowly but surely shrinking. Although it is 80 ft. below sea level and can have no outlet, the rivers flowing into it, the Volga, the Ural, the Terch and the Kur are not a match for the winds that blow over it. The sea abounds in fish, also seals and tortoises and there is an extensive local commerce, none of which, apparently, can last forever.

A new potato grown in France, *Solanum Commersoni,* contains a violet coloring matter which proves serviceable to chemists. If the potatoes are boiled in water the ferments are destroyed and the resultant colored solution keeps well. As an indicator it is very sensitive, turning green with alkalies and bright red with acids.

Joseph Hall has just retired after 57 years of service as an engineman for the Maryport & Carlisle Railway of England. He must have been fortunate as well as faithful, since he had never had a single mishap and had never had a demerit mark against him.

A miner carrying a glass jar filled with calcium carbide had arrived at his work in the mine when he let the jar slip and it was broken into many pieces on a rail. The carbide rolled into a ditch at the side of the track, where there was running water. The water generated acetylene gas, the light on the miner's head ignited it, then came an explosion, and he was badly burned.

The city of Buenos Aires, Argentine Republic, recently opened the first two-mile section of a subway system which, when completed, will extend eight miles and connect all parts of the city. The running time between the two important plazas connected by the subway has been cut in two. A unique feature is distinguishing stations by finishing each one in different colored tiles, one sky blue, one yellow, one green, etc., there being a station about every three blocks. Transfer tickets between surface lines and subway cost 2 cents.

Here are some of the characteristics of the 14-inch gun, carried by the New York and Texas. It is 45 calibres in length, that is 52 feet 6 inches. It weighs 63.4 tons, has a muzzle velocity of 2,600 feet per second, and fires a shell weighing 1,400 pounds. At a distance of 10,000 yards its shell will penetrate over sixteen inches of the hardest Krupp armor. The Nevada and Oklahoma will carry ten 14-inch guns in four turrets. The Pennsylvania and Battleship 39 will carry twelve 14-inch guns in four turrets.

An experimental test has been made in Paris of a portable road-mending machine, consisting of a six horse-power gasoline engine, actuating an air compressor, the air being led from a storage tank to a pneumatic rammer and a pneumatic pick, the latter being described as merely a modification of the well-known pneumatic riveter. The workman holds the tool close to the road and pushes the pick under the surface, raising it up as he proceeds. It is said that the work was done at a much faster rate than was possible with the ordinary pick. The pneumatic rammer also gave good results. One advantage of the system is that several men can work from the same compressor plant.

Over $14,000,000 worth of rapid transit contracts were let recently in New York, one of them being the largest single contract since the $35,000,000 contract awarded to John B. McDonald for the construction of the present subway. The contract now spoken of was for the construction of the two tunnels under the East River from downtown Manhattan to Brooklyn. Booth & Flynn, Ltd., and the O'Rourke Engineering Construction Co., on their joint bid of $12,444,726, secured the work. One of the tunnels will run from Whitehall St., Manhattan, to Montague St., Brooklyn, and will be operated by the New York Municipal Railway Corporation; the other will run from Old Slip, Manhattan, to Clark St., Brooklyn, and will be operated by the Interborough Rapid Transit Co.

The Roumanian government has awarded to Julius Berger Tiefbau Aktiengesellschaft the contract for building the Isvor Tunnel on the Sinaya-Moreni line. The tunnel is about 4 miles in length and the cost about $2,500,000, though the price is not fixed, but is calculated at fixed partial rates according to the material encountered. The time for construction is 28 months, and the work is to be begun at once. Part of the plant which the company is using for the Swiss Hauenstein Tunnel will be transferred to the Isvor Tunnel. The Hauenstein Tunnel, which is situated on the Basel-Sissach-Olten line, is 26,700 feet long, and satisfactory progress is being made, 14,500 feet having been pierced on the south side and 6,700 feet on the north side. The contract requires the lower headings to meet by January 13, 1916, and the line to be ready a year later, and the works are well ahead of time.

Manufacturers of the Naugatuck Valley, Connecticut, are making preparations to carry out a plan, which has been under contemplation for some years, to create a great reservoir to store the flood waters of the basin for use in dry seasons, to create power at dams lower down the stream, and especially to flush the river bed, that any nuisance that may exist will be eliminated. The engineers' plans call for a reservoir that will contain 15 billion gal., a capacity which has few equals in the East. The location is in Thomaston, where the dam will confine the waters of three important feeders of the Naugatuck River.

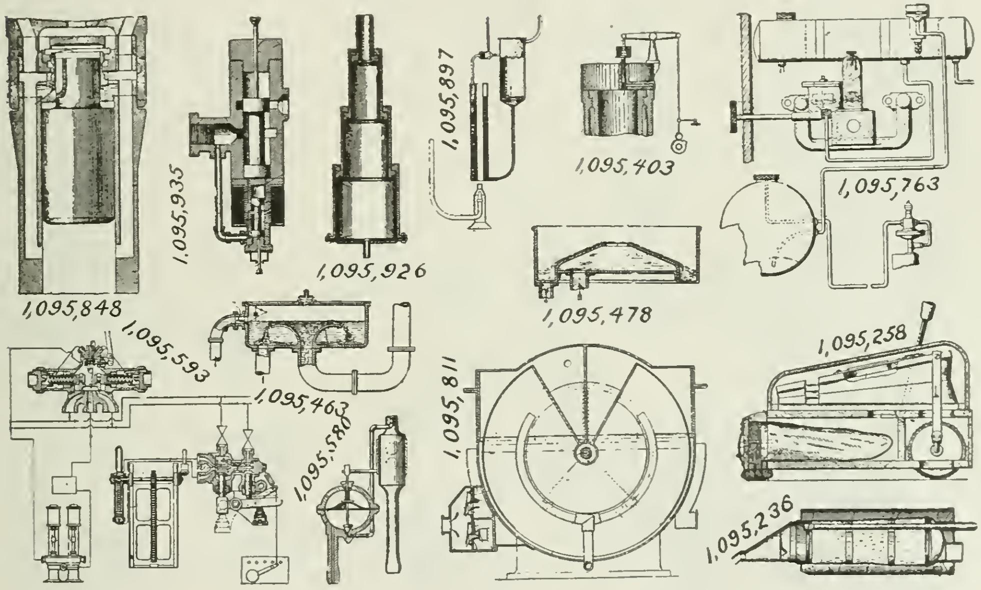
Snow disappears at high altitudes without melting. The matter is not a mysterious one for the snow actually does disappear as water vapor into the atmosphere, without melting. A reference to the equilibrium curve between solid, liquid, and gaseous water, which appears in nearly every recent textbook on physical chemistry, will show that the change from the solid to the gaseous state is the normal one at low pressures and temperatures.

The governments of Sweden and Denmark have had plans made for the construction of a tunnel under the sea channel that separates the two countries to accommodate a railway that will establish direct communication between Stockholm and Copenhagen. The submarine tunnel will be about nine miles. Some thirty miles of railway will have to be built in connection with the tunnel. It is estimated that railway and tunnel will cost about $25,000,000.

A novel method of preventing local fogs is at present being tested by experiment. During the winter months Lyons is frequently covered with dense fogs, caused by evaporation from the neighboring rivers. The Director of the Lyons Observatory has shown, from the contour of the land and the movement of fog banks, that if evaporation from the Saone could be checked for a stretch of about a mile and a half above Lyons, fogs over the town would be prevented. To effect this, 72 litres of oil are being spread over the surface each day. This small amount gives an oil film thick enough to stop the evaporation.

The Khojak tunnel in Beluchistan, with a length of two miles and 769 yd., is the longest railway tunnel in Asia. It is on the Chaman extension of the Sind-Pishin section of the North Western Railway of India. This extension was built between the years 1888 and 1891 in consequence of the fear of Russian aggression. The tunnel pierces an historic pass across the Khwaja Arman offshoot of the Koba-Kakar Mountains. Two lines, of the Indian 5 ft. 6 in. gage, are laid through the tunnel which is, like most of the tunnels on the northwest frontier of India, guarded at each end by strong iron gates.

It would appear that our railroads are not so bad after all. According to reports compiled by the Bureau of Railway News and Statistics, 299 railways of the United States, operating a mileage equal to the combined railways of the United Kingdom, Germany, France, Austria and Italy, went through the fiscal year ended June 30, 1913, without a single fatality to a passenger in a train accident. The railways, which operate together 120,901 miles of line, constitute more than two-thirds of the operating companies making their annual reports to the bureau. During the year these railways carried a total of 409,808,488 passengers an aggregate distance of 14,400,992,000 miles, and 968,764,956 tons of freight a total of 141,790,227,000 ton miles. Almost one-half the entire railway traffic of the United States for the year thus was carried without one passenger being killed in an accident to a train.



Pneumatic Patents May 5.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 5.

1,095,236. PUMP FOR VACUUM-CLEANERS. Julius Schirra, Pittsburgh, Pa.

1,095,258. VACUUM CLEANING APPARATUS FOR CARPETS AND THE LIKE. Morris S. Wright, Worcester, Mass.

1,095,403. COMPRESSED-AIR STARTING DEVICE FOR MOTORS. Olav Eskil Jorgensen, Copenhagen, Denmark.

1,095,463. APPARATUS FOR REMOVING AIR FROM WATER. Walter Kieser, Berlin, Germany.

1,095,478. MEANS FOR SEPARATING GASES FROM LIQUIDS. Fritz Strohbach, Charlottenburg, Germany.

1,095,498. DRYING JAPANNED OR VARNISHED LEATHER. Alfred Genthe, Worms, Germany.

The process of drying japanned or varnished leather which consists in drying air and passing it through a chamber, and exposing the said leather to light rich in ultra-violet rays in said chamber, the air being maintained substantially free from moisture.

1,095,580. OXYACETYLENE AND SIMILAR BURNER. Friedrich Krauss, Munich, Germany.

1,095,593. FLUID-PRESSURE SYSTEM FOR OPERATING BULKHEAD-DOORS. Frederic John Pike, Beckenham, and Herbert Neville, Forest Hill, England.

1,095,763. FUEL-SUPPLY SYSTEM FOR AUTOMOBILES. Alexander Winton, Cleveland, Ohio.

1,095,848. FLUID-PRESSURE-ACTUATED TOOL. George H. Gilman, Claremont, N. H.

1,095,871. DEVICE FOR OBTAINING A CONSTANT MIXTURE OF TWO ELASTIC FLUIDS. Alexander Constantine Ionides, Jr., London, England.

1,095,897. PROCESS FOR PRODUCING COMPRESSED AIR OR COMPRESSED GAS ESPECIALLY FOR THE OPERATING OF LAMPS. WILLIBALD LIEDKE, Berlin, Germany.

1,095,926. FLUID-PRESSURE CYLINDER AND PISTON. JOHN E. POWELL, Augusta, Ga.

1,095,935. ELECTRICALLY - CONTROLLED AIR-RELEASING VALVE FOR TRAIN-PIPES AND THE LIKE. THOMAS H. SHELDON, Victor, Colo.

MAY 12.

1,096,031. MINING-MACHINE. ARTHUR HENRY GIBSON, Easton, Pa.

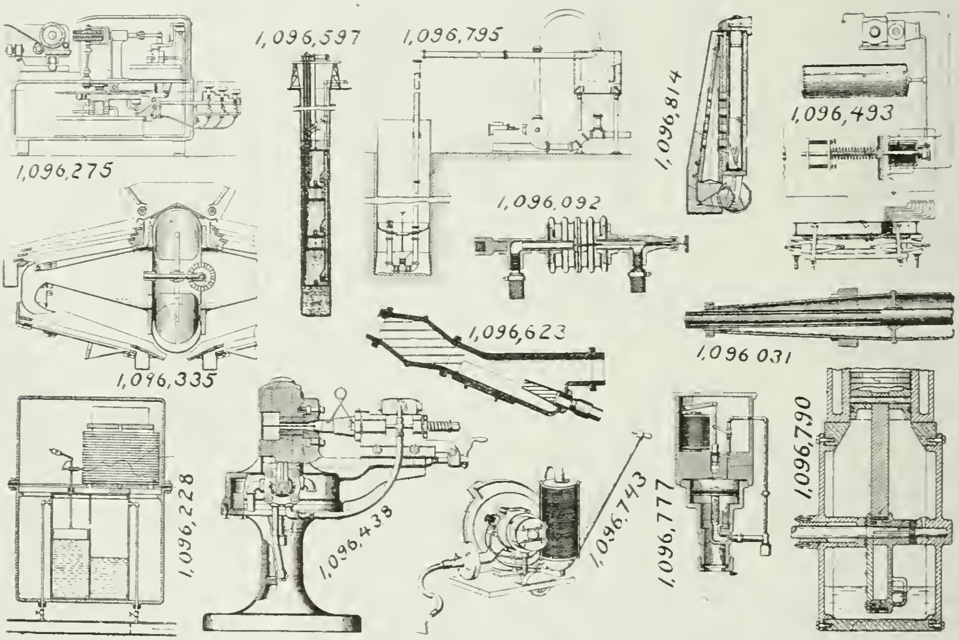
1,096,092. VIBRATOR. ELMER LOUIS BISSON, Berwyn, Ill.

1,096,228. GAS-MEASURING INSTRUMENT. JOSEPH P. DELANEY, Pittsburgh, Pa.

1,096,275. PNEUMATIC TYPE-WRITER. MAX SOBLIK, Dresden-Klotzsche, Germany.

1,096,305. PNEUMATIC POTENTIAL-PRODUCING MEANS. JOHN A. JOHNSON and CARL M. HEDMAN, Chicago, Ill.

1,096,334. AIR-BRAKE-SETTING DEVICE. JOHN H. WATTERS, Augusta, Ga.



PNEUMATIC PATENTS MAY 12.

1,096,335. DOUBLE SUCTION GRAIN CLEANER AND GRADER. WARREN WATTS, Hayes Township, Clay county, Kans.

1,096,408. DETECTOR AND ALARM FOR PNEUMATIC TIRES. SEYMOUR W. WATERHOUSE, San Jose, Cal.

1,096,437-8. FLUID-ACTUATED DRILL-BIT FORMING, SHARPENING, AND SHANKING MACHINE. JOHN GEORGE LEYNER, Denver, Colo.

1,096,493. LOAD-REGULATED GOVERNING DEVICE FOR FLUID-PRESSURE. JAMES S. DOYLE, Mount Vernon, and FRANK HEDLEY, Yonkers, N. Y.

1,096,597. PUMPING SYSTEM. WILLIAM A. BRUTON, San Dimas, Cal.

1. A pumping system comprising a plurality of submerged cylinders, a governor pipe and an inlet pipe extending into each of the cylinders, a discharge conduit, communicating with each of the cylinders and extending to the point of discharge, and valve means for controlling the entrance of compressed air to the air inlet pipes, said valve means being controlled by air conveyed from the cylinders through the governor pipes to said valve means, valve means at an intermediate point of the air inlet pipes for admitting compressed air from said pipes to said discharge conduit.

1,096,607. DIVER'S SUIT. JEAN F. DERAY, Sunnyvale, Cal.

1,096,623. ASH-CONVEYER. ALEXANDER GIRTANNER, St. Louis, Mo.

1,096,743. PNEUMATIC RENOVATING-MACHINE. AMON T. NOE, New York, N. Y.

1,096,777. AIR - BRAKE - CONTROL - VALVE MECHANISM. ANDREW J. ALLARD, Richmond, Va.

1,096,788. FLUSHING APPARATUS. PATRICK J. MADDEN, Chicago, Ill.

1. In a flushing apparatus, the combination of a main tank, means for discharging liquid thereinto, a priming tank having an opening communicating with the main tank, a float valve for controlling said opening, the under side of the valve being immediately exposed to the fluid pressure within the main tank, means for trapping a body of air immediately against said exposed under side of the valve, whereby as the liquid rises in the main tank it will compress the air and produce a sufficient fluid pressure upward immediately against the valve to unseat it, a siphon for discharging the liquid contents of the tank, and means for discharging into the priming tank a sufficient quantity of liquid to prime the siphon when the valve is unseated as aforesaid.

1,096,790. GAS - COMPRESSOR - DRIVING MECHANISM. CASPER W. MILES, Anderson township, Hamilton county, Ohio.

1,096,795. METHOD OF AND APPARATUS FOR SINKING SHAFTS. EDWARD O'TOOLE, Gary, W. Va.

1. The method of sinking shafts consisting in excavating within a caisson in forming the shaft depositing the excavated materials within a conduit leading from the caisson to the exterior

thereof, creating an outwardly flowing current of fluid pressure in said conduit to thereby carry water collecting in the caisson and the deposition of excavated materials there through and out of the caisson, separating and discharging the air independently of the removed solids carried through and discharged from said conduit, and causing the caisson to descend within the shaft as the excavation is deepened.

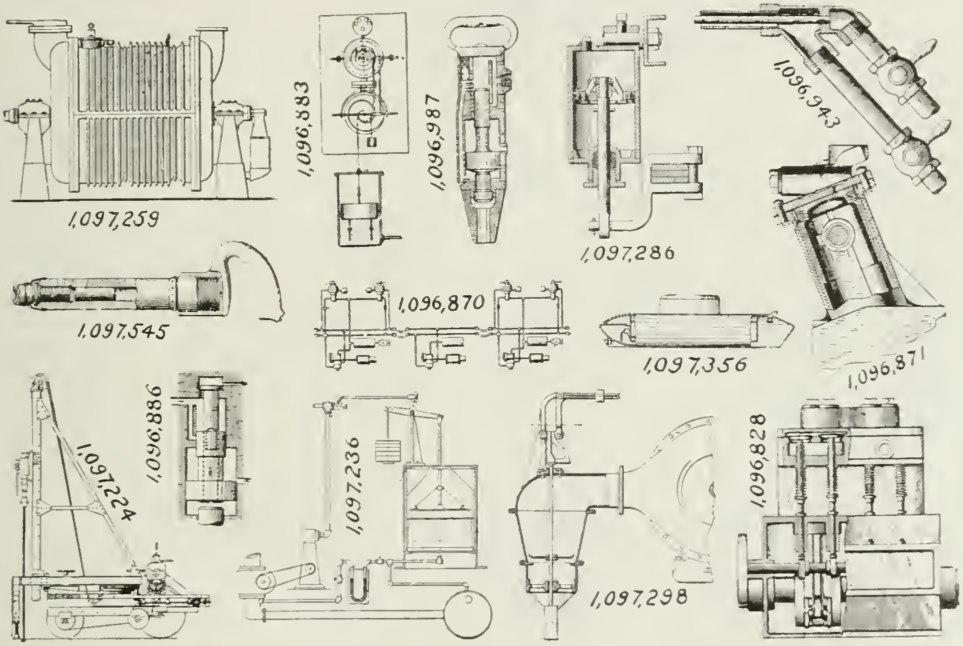
1,096,814. HAND-POWER VACUUM-SWEEPER. NELSON M. DYER and WILLIAM S. HOLBROOK, Davenport, Iowa. Filed July 12, 1913.

MAY 19.

1,096,828. VALVE MECHANISM FOR AIR COMPRESSORS. HUGH V. CONRAD, Pittsburgh, Pa.

1. The combination with a fluid compressor cylinder, of two inlet valves for controlling the admission of fluid to one end of the compressor cylinder and means for actuating said valves at different times.

1. In a water system, the combination of two gravity filled submerged reservoirs, two check valved conduits, one to each reservoir, led therefrom, a compressed air supply conduit, two air conveying conduits, one to each reservoir, a valve casing interposed between the air supply conduit and the two air conveying conduits, a valve mounted in said casing for alternately connecting the two air conveying conduits to the air supply conduit, a double lever connected to the valve, pneumatically controlled means operably connected to the respective ends of the said lever two conduits leading to the pneumatically operated means from the two air conveying conduits, a valve in each of said conduits, two floats, one mounted in each reservoir, two switches one controlled by each float, two electromotors for operating the valves of the pneumatically operated means, and two circuits including each a source of electrical energy, one switch of the reservoir, and one electromotor, whereby the valves are operated to alternately connect the two air conveying pipes to the air supply pipe.



PNEUMATIC PATENTS MAY 19.

1,096,832. APPARATUS FOR THE CONTINUOUS EXAMINATION OF LIQUIDS. OTTO FRIESE, Berlin, and FERDINAND GRAAFEN, Erfurt, Germany.

1,096,870. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,096,871. FLUID-COMPRESSOR. WALTER V. TURNER, Edgewood, Pa.

1,096,877. AUTOMATIC STOKER. HARRY L. WILLIAMS, Chicago, Ill.

1,096,883. FLUID-FLOW METER. HARLEY C. ALGER, Chicago Heights, Ill.

1,096,886. FLUID-OPERATED PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,096,943. BLOWPIPE. CARL H. PEAKE, Detroit, Mich.

1,096,959. PNEUMATIC SPRING-WHEEL. ALBERT O. SCHOELCH, Shelbyville, Ind.

1,096,987. FLUID-OPERATED PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,097,055-61. TRIPLE VALVE. JACOB RUSH SNYDER, Pittsburgh, Pa.

1,097,143. PNEUMATIC WATER SYSTEM. WILLIAM HENRY SINGLETON, Macon, Ga.

1,097,224-5. ROCK-DRILLING MACHINE. CHARLES C. HANSEN, Easton, Pa.

1,097,236. GAS - PRESSURE - REGULATING DEVICE. JESSE J. KERR, Cleveland, Ohio.

1,097,259. PREVENTING PULSATIONS IN CENTRIFUGAL COMPRESSORS. MELACH I. NUSIM, Lynn, Mass.

1,097,263-4. BLOWPIPE. WILLIAM I. REICH, New York, N. Y.

1,097,286. SHOCK-ABSORBER. JOHN BAKER, Jr., Los Angeles, Cal.

1,097,297. CENTRIFUGAL COMPRESSOR. JOHN G. CALLAN, Boston, Mass.

1,097,298. MEANS FOR PREVENTING SURGING IN CENTRIFUGAL COMPRESSORS. JOHN G. CALLAN, Boston, Mass.

1,097,356. AIR-SUPPLY APPARATUS FOR SUBMARINE VESSELS. PAUL PARNITZKY, New York, N. Y.

1,097,545. ATTACHMENT FOR PNEUMATIC RIVETERS AND SIMILAR TOOLS. HARRY B. GRINER, Philadelphia, Pa.

1,097,559. CONTROLLING MECHANISM FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

MAY 26.

1,097,706. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. Lewis B. Doman, Elbridge, N. Y.

1,097,729. CENTRIFUGAL AIR-COMPRESSOR. Richard H. Rice, Lynn, Mass.

1,097,756. ROTARY FLUID-PRESSURE MOTOR. Theodore M. Hiester, Dayton, Ohio.

1,097,783-4. PROCESS OF BLOWING ACID GASES. Robert B. Wolf, Berlin, N. H.

1. The process of blowing gases containing corrosive constituents, which consists in drawing the gases into the blower and introducing a neutralizing agent into the gas as it enters the blower for the purpose of depositing an inactive coating on the blower and finally delivering the gas therefrom.

1,097,804. PNEUMATIC EGG-CRATE. David A. Jones, Wayne, Nebr.

The combination with a box having a hinged lid, of a pneumatic cushion secured within the box and lid, said cushion comprising a lid carried air chamber, a box carried air chamber, and a plurality of tranverse longitudinal air cells disposed on and connected with the box carried chamber, the box carried chamber, the lid carried chamber and the said transverse and longitudinal cells all communicating with each other, and an inflating valve carried by the cushion member whereby all of the cells and chambers can be simultaneously inflated.

1,097,865. ANTISIPHON-TRAP. John Charles Lauth, Rochester, N. Y.

1,097,878. AIR-COMPRESSOR. Patrick H. Reardon, San Francisco, Cal.

1,097,879. PRESSURE-REGULATOR. James H. Reichard, New Orleans, La.

1,097,997. ROTATION DEVICE FOR FLUID-PRESSURE-OPERATED-HAMMER TOOLS. Albert H. Taylor, Easton, Pa.

1,098,046-7. STARTER FOR INTERNAL-COMBUSTION ENGINES. Don D. Miles, Jr., San Francisco, Cal.

1,098,119. BURNER FOR AUTOGENOUS WELDING AND CUTTING OF METAL. Marinus Kongsbak, Lubeck, Germany.

1. A device for autogenous welding and cutting of metal beneath the surface of water comprising a compressed air supply pipe, a ring on the inner end of said supply pipe and provided with apertures on one face thereof, a fuel supply pipe, and a burner on the inner end of said fuel pipe extending through said ring as described.

1,098,151. AIR-GUN. William A. Heilprin, Philadelphia, Pa.

1,098,172. FLUID-PRESSURE REGULATOR. Miron G. Reynolds, Anderson, Ind.

1,098,173. TIRE-INFLATING APPARATUS. Frederick A. Ruff, Newark, N. J.

1,098,247. APPARATUS FOR INDICATING OR MEASURING THE RATE OF FLOW OF FLUID THROUGH PIPES, OR FOR DETECTING LEAKAGE. George James Gibbs, Preston, England.

1,098,249. ATTACHMENT FOR PNEUMATIC RIVETERS. Harry B. Griner, Philadelphia, Pa.

1. In a pneumatic impact tool, a barrel having the lower portion of its bore of stepwise decreasing diameters, an impact-plug of corresponding stepwise decreasing diameters and fitting in said bore, and means surrounding a portion of said plug and adapted to contact with said barrel for preventing upward displacement of such plug.

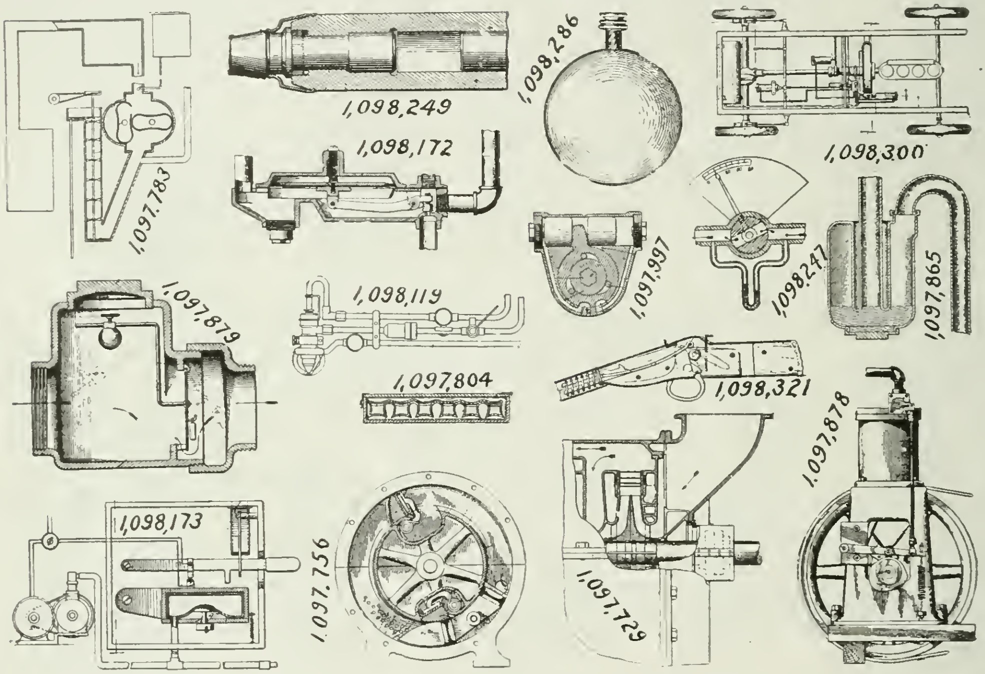
1,098,286. CLOSURE FOR INFLATABLE BODIES. Thomas W. Miller, Ashland, Ohio.

1. The combination with an inflatable body, of means for automatically retaining a portion of the same in a twisted condition to prevent passage of the inflating medium therethrough.

1,098,300. PNEUMATIC POWER-TRANSMITTER. Frank M. Prather, Los Angeles, Cal.

1,098,306. VENTILATING AND OTHER FAN. Henry Julius Trautmann and James Lloyd Copping, London, England.

1,098,321. AIR-GUN. William A. Heilprin, Philadelphia, Pa.



Pneumatic Patents May 26.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol XIX AUGUST, 1914 No. 8

SPEARFISH CREEK TUNNEL OF THE HOMESTAKE MINING COMPANY

To secure electric current for operating its mills, mine pumps, etc., The Homestake Mining Company, Lead, S. D., has developed a water power of 6000 k.w. capacity from the fall of Spearfish Creek securing a working head of 665 ft. An interesting account of the entire installation is contributed to Mining and Engineering World by Mr. Richard Blackstone, Chief Engineer and Assistant Superintendent of the Company. Our readers will be chiefly interested in the construction of a long water tunnel which was an important detail of the work, and the following description we abstract from the article above referred to.

From the side of one bank, just above the dam, the water enters the intake of the tunnel which extends in practically a straight line 23,800 ft. (4½ miles) in the direction of the power house. The finished tunnel is 6½ ft. wide with vertical sides 5 ft. high and a semicircular roof with a radius of 3 ft. 3 in. It was driven through solid rock in sections, crosscuts being made through the hill from suitable points along the route. The sides and floor of the tunnel are lined with concrete, and the arched roof is similarly lined for three-fifths of the length.

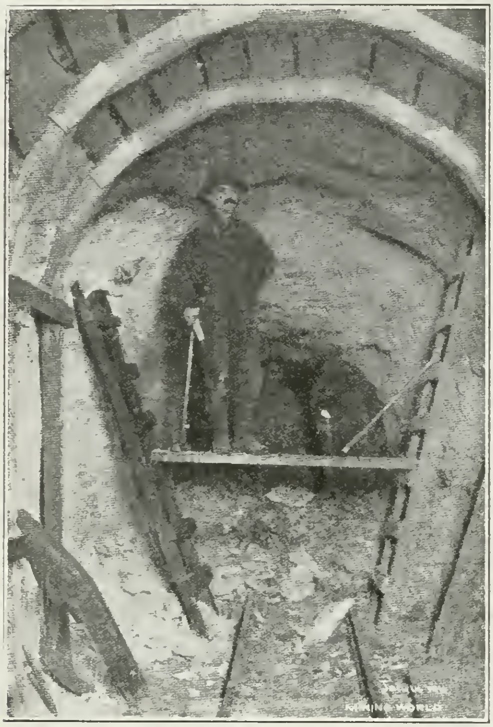
It was found that the tunnel could extend from the intake to the forebay on a very direct line, and that the side canyons or ravines cut into the line of tunnel at intervals, which naturally divided the work into sections of convenient lengths for rapid excavation, as follows: Section one, 1695 ft.; section two, 4152 ft.; section three, 4082 ft.; section four, 4154 ft.; section five, 1284 ft.; section six, 3762 ft.; section seven, 2074 ft.; section eight, 2389 ft., or a total of 23,862 ft. Crosscuts were driven in, on the grade level, at each of the stations to the intersection of the tunnel center line, each intersection being an angle point in the tunnel—except at station five. In locating these angle points it was planned to have the tunnel in solid rock, rather than in loose rock or earth, to save timbering and avoid "running" ground, regarless of the length of crosscuts.

ELECTRIC POWER ENTIRELY.

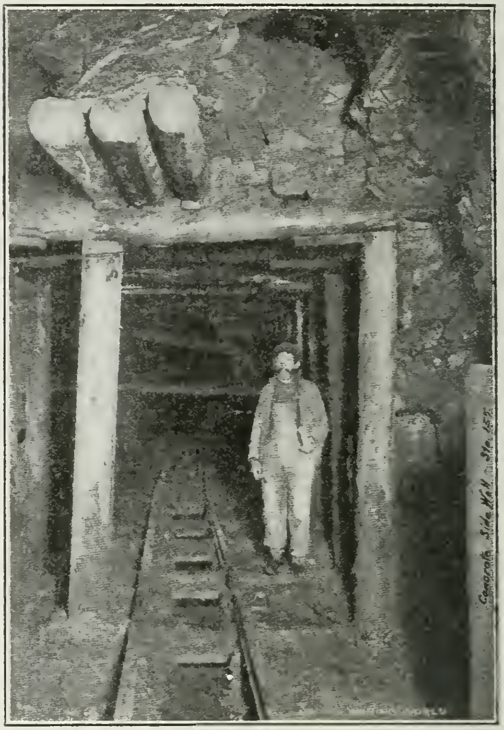
The company was the owner of a hydro-electric power plant near the northerly end of the tunnel. It had been built for lighting Spearfish town and was equipped with one 100-kw., 2300-volt, alternating-current Westinghouse generator. This electric output was used not to exceed 8 hours out of 24. Another 100-kw. Westinghouse generator of the same voltage was installed, so both could be run in multiple.

A transmission line was built up the valley to the intake, with branches to each station. Transformers were erected as near the tunnel entrance as convenient, stepping down current to 220 volts, with leads to the Temple-Ingersoll electric air drills at the working faces of the tunnels, and to the Sirocco blowers, which furnished the ventilation to the miners working in the tunnels. It was also used to pump water from Spearfish creek to Stations Nos. 2, 3, 7 and 8. The Nos. 7 and 8 pumps worked against a head of 600 ft., delivering 10 gals. per minute. Gravity water was available at Stations Nos. 4, 5 and 6. Fourteen Temple-Ingersoll electric air drills were used, allowing extra ones for repairs. Drill sharpening shops were built at the tunnel levels and close to crosscut entrances.

All tunnel work was done in three 8-hour



DRESSING DOWN FOR TIMBERS.



TIMBERING FOR BUILDING SIDE WALLS.

shifts. The crosscuts were driven to the center line surveyed for the tunnel, and turned right and left, making two working stations for each crosscut. The tunnel, as above noted, is divided into eight sections, three of which were over 4000 ft., as stated. The drilling was done in one face, with a single drill, and mucking in the other, alternating with each shift. Each shift started drilling and blasted one round of holes, while their muckers were working at the other face. The rough section of tunnel excavation was about 8 ft. wide by 9 ft. high. From 12 to 14 5-ft. holes were drilled for each round. The center-cut method was used, fired by hand; cut holes, side holes and back holes, with lifters last. Steel sheets, 120 by 30 by ⅜-in., two at each face, were used as floors to shovel from. The regular Homestake mine cars were used for mucking, and were hand trammed to dump on all sections of the tunnel; 200 gross tons of steel rails, 20-lbs. per yard, were used, with 4 by 6-in. sawed pine ties for supporting the track.

Two or three large pockets of water were tapped. One in tunnel No. 4 broke out suddenly and in great volume, pushing the miners out of the tunnel. This soon drained down, but disclosed a great open gash in the limestone rocks, filled with loose rock, boulders and mud; and it proved a trying piece of work before the run of debris was bulkheaded off. In tunnel No. 2 several strong streams of water were cut and proved to be permanent in their flow, slowing down the progress in this tunnel which was the last to hole through.

MAXIMUM POWER CONSUMPTION.

It may be of interest to note that the maximum metered power used in driving this tunnel seldom exceeded 30-hp. The power used was metered, and a daily report made of the current put on to the tunnel transmission line.

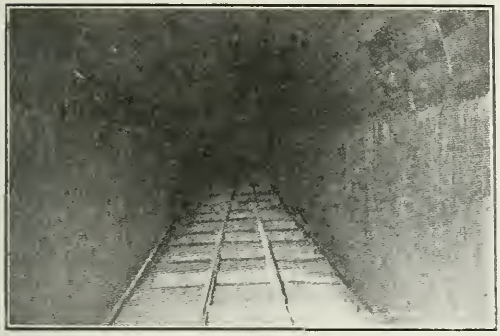
The ventilating was accomplished by means of Sirocco fans having a capacity of 500-cu. ft. per minute, through 2000 ft. of 9¼-in. galvanized iron pipe made on the ground from sheets delivered there. These were put together with slip joints and sealed with muslin asphalted to the pipe. The pipe was kept within 200 ft. of the face of the drift extension, wood boxes being used at the discharge ends

ROOF FORMS FOR CONCRETING.

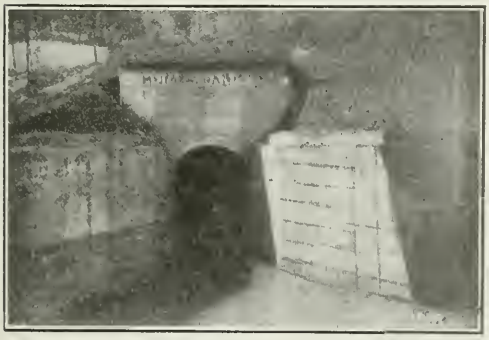
as protection against flying rocks from the blasting and to carry air near to the face of the tunnel.

TUNNEL PROGRESS.

The progress made in the tunnel is shown in the appended table. The work was begun in May, 1909, and finished in October, 1910. For driving the tunnel we employed miners, a great many of whom were from the Homestake mine, and the shift bosses were all of our own selection. This work was in progress at the time of the trouble in Lead, when the change from union labor was made, and we passed through it without any suspension of operations. In connection with this work, the building of construction camps and roads formed a considerable item of cost, including roads to the crosscuts. It amounted to about 20 per cent. of the whole. To our advantage, however, was the proximity of the Burlington railroad for supplies, enabling us to unload material at any one of the crosscut stations.



TUNNEL LINING FINISHED.



DISCHARGE FROM TUNNEL.

TABLE SHOWING TUNNEL PROGRESS.

Date.	Ft. per week	Powder per ft., lbs.	Power (HP.)
Dec. 19, 1909	404	17.0	21.9
Dec. 26, 1909	400	17.0	21.9
Jan. 2, 1910	420	15.0	23.2
Jan. 9, 1910	424	17.0	23.2
Jan. 16, 1910	431	15.0	22.9
Jan. 23, 1910	455	15.0	26.3
Jan. 30, 1910	504	14.0	24.9
Feb. 6, 1910	562	15.0	12.9
Feb. 13, 1910	550	15.0	25.5
Feb. 20, 1910	539	16.0	26.1
Feb. 27, 1910	516	17.0	25.6
March 6, 1910	551	15.0	26.6
March 13, 1910	576	15.0	30.0
March 20, 1910	503	17.0	28.6
March 27, 1910	496	17.0	29.4
April 3, 1910	514	17.0	31.4
April 10, 1910	494	17.0	32.
April 17, 1910	516	16.0	32
April 24, 1910	524	14.0	30.7
May 8, 1910	546	16.0	30.7
May 15, 1910	608	15.0	33.7
May 22, 1910	553	15.0	32.3
May 29, 1910	459	17.0	30.8
June 5, 1910	517	17.0	32.9
June 12, 1910	518	13.0	27.2
June 19, 1910	527	9.0	28.1
June 26, 1910	424	14.0	25.7

	Began.	Finished	Feet.	Daily av. Feet.
No. 1	July 9, 1909	June 22, 1910	1,965	5.65
No. 2	July 9, 1909	Oct. 8, 1910	4,152	9.10
No. 3	July 23, 1909	Aug. 12, 1910	4,082	10.60
No. 4	July 10, 1909	July 29, 1910	4,154	10.82
No. 5	Aug. 22, 1909	Jan. 5, 1910	1,284	9.45
No. 6	Sept. 10, 1909	Aug. 5, 1910	3,762	11.40
No. 7	Sept. 30, 1909	June 23, 1910	2,074	7.77
No. 8	Dec. 8, 1909	Sept. 4, 1910	2,389	9.00

Water from a subterranean stream bursting through the lining flooded the Simplon tunnel in Switzerland to a depth of 2 ft. on July 7. Workmen were immediately rushed to the tunnel to repair the tracks and pump out the water, and it was hoped that traffic could be re-established in a few days. A train was derailed in the middle of the tunnel, but no one was hurt. During the interruption on the Simplon line traffic was diverted to the St Gothard tunnel

MEASURING COMPRESSED AIR FOR COST DISTRIBUTION

BY B. B. HOOD

Compressed air is used around mines for purposes other than rock drilling, and in order to apportion the costs fairly a measurement of the various quantities is usually desirable Various meters are obtainable that will do this, but they are expensive and not always at hand. At one of the mines in northern Michigan, it was necessary to ascertain approximate figures of air consumption as a basis for cost distribution.

One steam-driven, 5000-cu. ft. Nordberg compressor supplied the air for the mine. This was practically new and in good order. The pressure of 75 to 80 lb. was kept on the mains for 120 hr. per week. A week was taken for the period during which measurements were to be made. The air delivered by the compressor was consumed as follows: (1) Pipe-line losses; (2) Saturday afternoon blowoff; (3) blacksmith shop; (4) two rock houses; (5) rock drills and blowing powder gases; (6) underground pumps.

To account for the large line losses at the time of this test, it may be well to describe the lines. The surface air lines consisted of nearly 6000 ft. of 8-in. pipe buried in the ground. A large part of it was galvanized spiral-riveted pipe. This failed as an air pipe in two ways. The ends of each length of pipe was fitted with pressed-steel flanges. The faces of these flanges were not true and the surfaces were too small to hold a gasket after the latter had become saturated with oil; consequently they blew out and had to be often repaired. The continual expansion and contraction of the line, due to its having to carry hot air for some hours and then cool off, loosened the riveting. Some pieces of pipe would have small leaks throughout their entire length. These failures were most apparent in the 500 ft. nearest the compressor. The underground air lines were practically tight. As they were exposed to inspection, this was verified and no account of their loss was made

The compressor had a minimum capacity of 845 cu. ft. of free air per min. Repeated attempts to make it run slower than this were not successful, as the flywheel would not carry it over centers. This was more than the pipe-line loss, so one afternoon between 5.30 and 6.45, when the compressor was usually shut down, a blowoff valve was adjusted to allow the 845 cu.ft. per min. at 78-lb. gage pressure to escape. The air mains were shut off from the compressor during this adjustment, then they were charged with air at 78 lb. and the increased number of revolutions of the compressor noted over a period of 30 min. From this it was computed that the surface-line loss was 205 cu. ft. of free air per min. Figuring that the pressure was maintained on the lines for 120 hr. per week, this would amount to 1,480,000 cu. ft. of free air, which was the line loss during that period of time. The underground lines were shut off during this test because all of the machine valves were open to blow powder smoke.

No air was used underground from Saturday noon until Monday morning, but it was required for other purposes until 11 p. m. Saturday evenings. At times the demand would fall below the minimum capacity of the compressor, and in order to keep the engine running it was necessary to blow off some of its product. A small receiver was made of pipe fittings. This was furnished with an orifice 1½ in. in diameter in a $^3/_{16}$-in. plate, a thermometer, and a pressure gage. The instrument was used as a blowoff one Saturday afternoon. Compressed air was admitted into the receiver through a valve and was controlled to meet the requirements of the compressor. The pressure and temperature of the air in the receiver were taken at intervals. From these readings it was computed that the total free air blown off during the afternoon and evening was 338,000 cubic feet.

The air used by the blacksmith shop was measured by means of pitot tubes placed in a tube 20 in. long with a true 1-in. bore. The pitot tubes were made of $^1/_{16}$-in. outside diameter copper tubing. They were soldered into a ⅜-in. to ½-in. pipe bushing, so that when the latter was screwed into a tapped hole in the side of the 20-in. tube, they extended into the tube ¼ in. One of them faced the air current while the other was square with it. They were connected to a glass U-tube made of two steam-gage glasses connected at their lower ends with rubber hose. Water or mercury was used to determine the velocity head of the current of air. The 20-in. tube was fitted with a thermometer and a pressure gage some distance from the pitot tubes and behind them so that eddy currents were kept from the tubes. The following formula was used to compute the air flowing through the tube:

$$Q = 135 \sqrt{\frac{H\ (P + 14.7)}{t + 460}}$$

Where

Q = Cubic feet of free air per min. at 60° F. and 28.5 in. barometer flowing in the 1-in. tube;

H = Height of water in inches representing velocity head. (When mercury was used, the readings were multiplied by 13.6, the specific gravity of the mercury.)

P = Gage reading;

t = The temperature of the compressed air (° F.).

The instrument was set in the air line some little distance from the blacksmith shop, so as to have between it and the shop some receiver capacity in the shape of pipe line. This took off some of the sharp peaks in flow caused by the drill sharpener and the hammer. It was found that the drill sharpener, furnace and forge working 36 hr. per week used 550 cu. ft. of free air per min., or 1,188,000 cu. ft. per week; the other forges in 18 hr., at 160 cu. ft ; the hammer in 6 hr., at 720 cu. ft. of free air per min., used 259,200 cu. ft., giving a total for the shop per week of 1,620,000 cu. ft.

Air was supplied to two rock houses to operate chute gates and drop hammers. On Saturday, from noon until 11 p. m., compressed air was used by the rock houses and for 2¾ hr. by the blacksmith shop. On the Saturday afternoon of the week of the test, the following was obtained: Total air compressed from noon till 11 p. m., 670,000 cu. ft.; blowoff, 338,000 cu. ft.; line loss, 118,000 cu. ft.; blacksmith shop, 27,000 cu. ft., leaving for the amount consumed by the rock houses in 8 hr. actual operation, 187,000 cu. ft. In the 72 hr. per week of rock-house operation, about 1,683,000 cu. ft. of air was, therefore, required.

Most of the rock drills were of the 3⅛-in. piston type. Arrangements were made to suspend pumping for one shift during the week, and make it up during the next shift. During that time there were 22½ drill shifts worked. The following results were obtained: Total air compressed during the shift, 1,439,000 cu. ft.; line loss, 120,000 cu. ft.; blacksmith shop, 270,000 cu. ft.; rock houses, 140,000 cu. ft., difference consumed by drills, 909,000 cu. ft This was used both for actual drilling and for blowing the powder smoke. The mine had good natural ventilation, so that the compressor was shut down soon after drilling ceased. If the drill machines operated on an average of 4½ hr. actual running time during the shift, the figures reduce to 150 cu. ft. per machine per min., which is a figure often used when estimating compressor capacity required. During the week in question, there were 111¼ machine shifts worked, which required, on the basis of the figures, 4,490,000 cu. ft. of free air.

Pumping water with air is expensive. One of the mine pumps had been previously tested. An Ingersoll-Sergeant 12 and 14¼x14-in. compressor furnished air for a No. 10 Cameron mine pump, 14 and 8x13in. No other uses were made of the air and the air line in this case was tight. Indicator cards were taken from both the air and steam cylinders of the compressor. The valve adjustments were good and the pistons tight. The total pumping head of the pump, including suction and pipe friction, was 103.1 ft. The water pumped was measured by a 4-in. orifice in a tank at the surface. The overall efficiency from steam indicated horsepower to useful work done on the water was only 6.81%. In the present case, the amount of air used by the mine pumps during the week was determined by difference, as is shown in the following table, which also gives the complete air distribution for the week.

It is true that succeeding weeks might not have had the same distribution percentage, but to obtain an accurate distribution for the cost sheet of each month would take an expensive equipment.—*Eng. and Min. Journal.*

	Cu.Ft. Free Air	Per Cent. of Total Compressed	Per Cent. Total Delivered by Mains
Total air compressed....	19,200,000	100.0	....
Airline losses	1,480,000	7.7	....
Blowoff	338.000	1.8	....
Blacksmith shop........	1,620,000	8.4	9.3
Rock houses............	1,683,000	8.8	9.7
Rock-drilling machines.	4.490,000	23.4	25.8
Underground pumps....	9,589,000	49.9	55.2

A MINE AT THE PANAMA-PACIFIC EXPOSITION

The U. S. Bureau of Mines has undertaken to construct, in co-operation with the mining industry and the manufacturers of mining machinery, a mine beneath the floor of the Palace of Mines and Metallurgy at the Panama-Pacific Exposition.

The financial and operative success of the mine is assured through exhibits promised, whereby typical metal and coal mining operations will be reproduced by full-size working places, in which mining machinery will be installed and operated. The walls of the mine will be covered with either ore or coal typical of the mine illustrated. Among others, the Copper Queen Co. of Arizona, Bunker Hill & Sullivan Co. of Idaho, Homestake Mining Co. of South Dakota, Goldfield Con. Mines Co. of Nevada, Jones & Laughlin Co of Michigan, Lehigh Coal & Navigation Co. of the anthracite field of Pennsylvania, Pocahontas Fuel Co. of West Virginia, Consolidated Coal Co. of Kentucky, and Pacific Coast Coal Co. of Washington, have each agreed to reproduce one of their working places or stopes, and to contribute the sum necessary to the installation and operation. Tentative promises of similar action have been received from the Rock Island Coal Co., Peabody Coal Co., and Pittsburg Coal Co.

Mining machinery and appliances have been promised in abundance and in full variety from the various manufacturers.

The entrance to the mine will be through the Bureau of Mines space, and visitors will be attracted to it by being given portable mine lamps, and by being lowered in a cage, while a panoramic effect of the strata lining a shaft will pass by them so rapidly as to produce the illusion of descending to a considerable depth. In case of crowds, these may enter by a slope. Exit will be by a slope into the radium booths of the Bureau of Mines, where actual radium emanations will be shown.

There will be a motion picture room which visitors will pass in going from mine to mine. In it will be shown such great open workings as are not illustrated by the underground mines, such as those of the Utah Copper Co. and those of the Nevada Con. Co. at Ely, the iron diggings at Hibbing, Minn., hydraulic gold mining, and the quarrying of building stone.

Twice each day there will be an "explosion" or fire in some portion of the mine announced by telephone to the superintendent's office in the Bureau of Mines space on the surface, and rescue men wearing breathing apparatus will enter the mine and bring out "victims" who will be given first-aid treatment in the surface emergency hospital.

In the Bureau of Mines space on the floor of the main building there will be, in addition to the radium booths, exhibits of carnotite, pitchblende and other radium ores, their alloys and concentrates, an emergency mine hospital and smoke room for rescue training, exhibits of fuel efficiency, smoke abatement, explosives, mine welfare work, etc.

The prime purpose will be that of educating the investing public, stockholders, members of legislatures and the uninformed antagonists of the industry relative to the importance of the mining industry, its extent, variety and the cost of operation.

PNEUMATIC AUGERS IN AUSTRALIAN MINES

In our issue for March of the present year, at page 7166, a brief note called attention to the use of the pneumatic auger for removing timbers in Central Mine, Broken Hill, N. S. W. Mr. James Hebbard, manager of the above mine, kindly sends us some additional particulars as follows:

The principal work for which the auger is used here is in the repair of crushed timbered drives and crosscuts. In this operation large quantities of old 10 by 10 in. Oregon pine legs and caps have to be removed, together with the decking, in restricted spaces where the use of axe or saw would be tedious at best or almost impossible. The drills are also very useful in various other minor jobs, such as for boring holes for hanging bolts in shaft sets, or for bolts for hand rails at shafts and winzes.

The tool used is the No. 11 Imperial Piston Drill, and the auger bit found most suitable is 1½ in. diameter. This is for our Oregon pine; a smaller bit would doubtless be preferable for hard wood. The advantages of the pneumatic auger over axe or saw for cutting through heavy timbers in the confined limits of a narrow drive will be readily appreciated.

Coal tar is now used as a fuel in steel furnaces at Gary, Ind. It is first heated to liquid form, then sprayed into the furnaces, mixed with blasts of air under pressure.

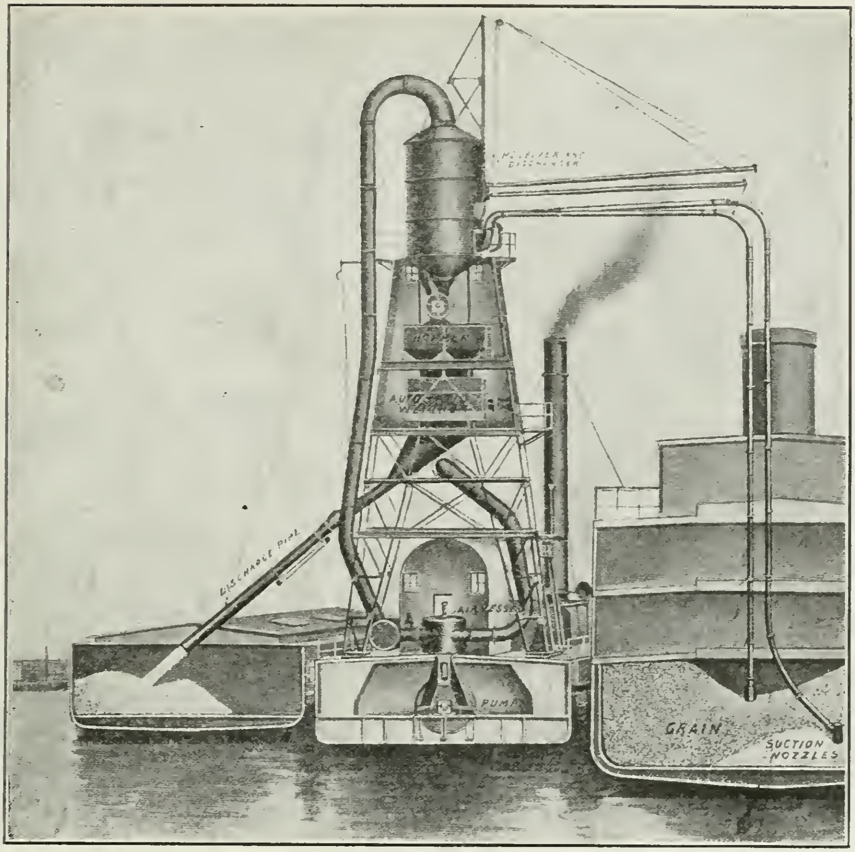


FIG. 1.

PNEUMATIC GRAIN ELEVATORS*

BY JACQUES BOYER.

It has become a well-established custom, in handling grain in large quantities, to use bucket-chain elevators for vertical transfer, and worm conveyors or traveling belts for horizontal motion. By such means as this, a large cargo can be loaded or unloaded in a very short time and with but small expenditure of power, even if the vessel is anchored at some distance from the store of grain.

But apparatus of the kind mentioned presents one disadvantage: If any change is to be made in the path of travel of the material handled, it becomes necessary to introduce more or less complicated intermediate apparatus, and the natural simplicity of the installation is therewith forfeited. In fact, the handling of grain cargoes in port presents technical difficulties which vary according to the size of the ships, the location of the cargo, etc. Thus, on first starting to unload, the grain reaches right up to the hatchway, say 15 to 20 feet above water-level, so that the bottom of the elevator must be set at that elevation. Later, as the cargo dwindles down, the elevator must dig deeper and deeper, ultimately, some 20 feet below the water-level. Finally, when the cargo is completely unloaded, it becomes necessary to lift the end of the elevator over the deck, say 40 feet above water-level. In other words, the end of the elevator must be capable of an extreme travel over some 60 feet up and down, or more in the case of large modern transatlantic steamers.

In view of these difficulties, the older methods, using bucket chains, etc., have been largely abandoned in favor of pneumatic grain conveyors. These consume a little more power

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*Scientific American Supplement. Translated from *La Nature*.

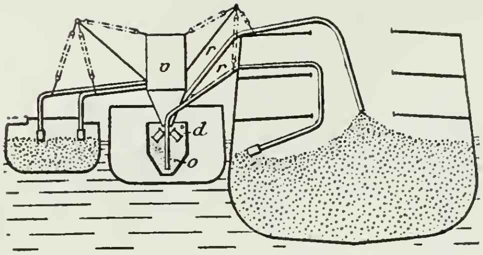


FIG. 2.

than the older types, but offer great advantages in point of ease of handling, economy of space, improvement of the merchandise (since dust is automatically separated from the grain), etc.

One of the most recent types of pneumatic grain elevators is constructed by a German firm of Brunswick, on a principle diagrammatically indicated in Fig. 2. In this drawing, *v* represents a vacuum chamber, kept exhausted by means of vertical or horizontal piston pumps. Air is thus sucked in through the pipes *r* and draws with it the grain from the hold of the steamer. The grain falls upon a double weigher *d*. This is shown in detail in Fig. 3, and consists of two drums *R* R_1 which are pivoted on a horizontal axle *T*, and can thus be brought, the one or the other, in alignment with the opening of the hopper *V*. As soon as one of these drums is filled, it tips over and discharges, while the other drum steps into charging position.

The following table shows the power consumed by the elevator here described:

Quantity of Grain Handled per Hour. (Tons).	Horse-power Consumed.
20	42
40	75
75	135
100	175
150	250

An important installation has been constructed on this principle at Brake on the Weser (Germany). This comprises four conveyers with a total capacity of 800,000 pounds per hour. The first three of these are placed on floats, the fourth is attached to a grain storehouse. The power required for the elevator and accessories is derived from five rotary motors having an aggregate capacity of 1,000 horse-power.

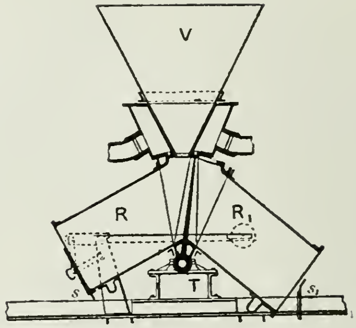


FIG. 3.

AN ENGLISH APPRECIATION OF THE CATSKILL AQUEDUCT

The following is taken from a report of an address by Mr. W. T. Taylor at a London meeting of the Society of Engineers.

As an exploit of purely technical engineering, the creation of the Catskill aqueduct and the Ashokan reservoir surpasses the Panama Canal. Apart from the unique methods of handling materials on the latter, it may be roughly stated that the problem meant merely digging out earth and rock on a large scale and dredging channels; to build the aqueduct meant piercing mountains and undermining rivers, traversing deep, broad valleys, and tunnelling through the bowels of the city of New York from end to end. The tunnel alone is 34 miles long—the longest in the world—and lies 200 ft. to 750 ft. below the city streets. In a few months the first link will be completed. One hundred and twenty-seven miles away the water will begin its three days' journey to the southernmost end of the metropolis from Ashokan reservoir in the Catskill Mountains, and running through a giant aqueduct, pass down the westerly side of the Hudson River, cross under through a huge, deep siphon at Storm King, thence to the Croton reservoir system, and through the present distribution pipes to New York. The aqueduct, the longest and deepest in the world, has an easy flow of 500,000,000 gallons a day. The principal quantities of work and materials involved in the Catskill system, as planned for the first development from the Ashokan reservoir to Hill View, are approximately 4,430,000 cubic yards of masonry, 17,170,000 cubic yards of excavation, 18,425,000 cubic yards of embankment, 21,250 tons of steel pipe and other metals, and 5,450,000 barrels of Portland cement.

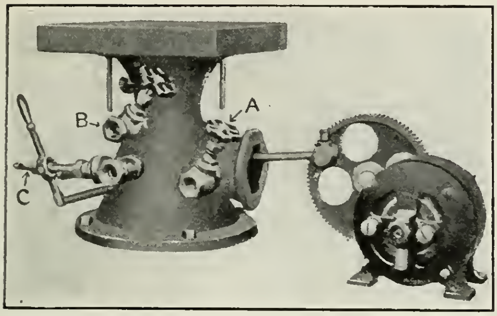


FIG. I.

A PNEUMATIC JAR-RAMMING MACHINE

The illustrations on this page, reproduced from Foundry, show an interesting pneumatic jar-ramming machine which seems to have taken an idea, and adapted it with some variations, from the electric air rock drill. The machine is entirely self contained, being actuated by an electric air motor which is an integral part of the apparatus. Normally, when work is going on the motor runs constantly, driving the piston of the horizontal compressing or pulsating cylinder. Atmospheric air is admitted to this cylinder through the intake valve A, and is compressed by the advancing piston so that the pressure raises the vertical plunger and table and when the exhaust port B is uncovered the air escapes and the table drops, giving the required jar to the flask of sand on the table. The jarring operation is controlled by opening and closing valve C, which in Fig. 1 is shown open.

By substituting a through-way valve for valve C sufficient air can be compressed while the machine is not jolting to be used for the vibrator, the blow-gun, or to raise the table for pattern drawing. In Fig. 1 the gear case has been removed. The exhaust is connected to this gear case. When in position the air, containing more or less oil serving to lubricate the running parts and also providing a slight pressure sufficient to keep out sand and dust. As the case is not air-tight the air escapes without any other provision. The machine is built by William T. Krause, 3623 North Ashland avenue, Chicago.

There has been recently such a demand for copper abroad that 300 tons of the metal were shipped on the first eastern trip of the Vaterland.

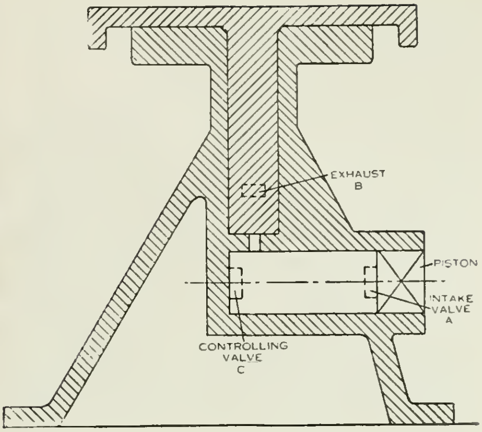


FIG. 2.

FORM FOR MISSED-HOLE REPORTS

An ingenious method for reducing the probability of missed-hole accidents was adopted in sinking the Monarch-Pittsburg shaft, at Tonopah. The idea is not entirely new, having been used in the Cœur d'Alenes previously. A blank form was placed in a conspicuous place of the change house, and in the rectangle a plan of the holes in the shaft bottom was made. The shift coming off after blasting, marked rings around the dots representing the holes which it was suspected had missed, and each member of the shift signed below. The shift coming on also signed at the bottom as an indication that each member had examined the diagram. Two purposes were served by this device. (1) The new shift was forced to receive information of the possibly dangerous holes; (2) the liability of the company to damage suits was decreased, since the signatures of the men would show that they were informed of the danger.

Experiments have been carried out at Toulon with a new type of diving bell invented by an Italian engineer. The bell is without internal air pressure and is fitted with hammers, tongs, and other tools, fastened to the outside, but capable of manipulation from within the bell. The inventor had a narrow escape from death when testing his bell. He had descended to a considerable depth, when the bell became entangled in some rocks, and half an hour elapsed before he could be released from his dangerous situation.

A SURFACE CONDENSER FOR STEAM ROCK DRILLS

BY FRANK RICHARDS.

A special drill scow for submarine work, with at least one unique feature, has been doing excellent service in channel and harbor improvement work at Bermuda. As is well known, all fresh water available anywhere in the Bermuda Islands is rain water stored in tanks and sold at various prices up to $4.50 per ton. This makes the use of steam in any considerable volume, without recovery of the water, almost prohibitive. A special drill scow adapted to the conditions, operating two large submarine drills, a steam winch and a steam pump, is equipped with a simple surface condensing arrangement so efficient that only 1½ tons of water per week are required for renewal or replacement. Besides the saving of the water, which is most important, there is a considerable saving of coal, there is no exhaust steam and no noise around the work, and there is always pure feed water. Practically no cylinder oil is used for internal lubrication and oil makes no trouble in the boiler.

Before the building of the scow, the drills were located one on each side of the dredger "King George," which necessitated the complete cessation of dredging whenever drilling was necessary. In other words, an expensive dredger had to be temporarily turned into a drill scow. As a considerable amount of rock has been encountered that could not possibly be dredged without blasting, about four days' blasting were required to give two days' dredging, the arrangement resulting in an output of 800 to 1000 tons per week. Since using the drill scow, and alternating the work of drill scow and dredger at different portions of the channel, the average per week has been raised to over 4000 tons.

The scow is 41 feet long, 25 feet wide and 5 feet deep, draws about 15 in. of water, and after six months' continuous service is as "tight as a bottle." The framing is 4x8 in. and the planking and deck is 2½x12 in. To protect from worming the bottom is covered with three coats of tar and arsenic.

The scow is moved from place to place by kedge and warp from the niggerhead of the steam winch, and the moorings are handled from the same, the drum of the winch being used for hoisting. There are four spuds, two 8x8 in. and two 9x9 in., 34 ft. long and all steel shod. These are located in spruce spud guides 10 ft. long, securely fastened to each corner of the scow. Each spud is hoisted from the niggerhead of the winch through lead blocks and a sheave on top of an 8x2-in. upright. It is held down by a wire down-haul pendant and fall secured by an eye bolt in the deck and led to the niggerhead to give it tension.

The boiler is a vertical tubular, 4 ft. in diameter, 6 ft. 6 in. high, with 140 tubes, 3 ft. 4 in. long, the usual steam pressure being 60 lb., gage. The boiler easily supplies the two drills, the air pump and a duplex pump for forcing water into the holes when drilling. This latter pump was found extremely beneficial in removing the material in the soft strata which would fall down and choke the drills.

The air pump used is a 4x6x8-in. Davidson, and the condenser consists of 160 running feet of 2-in. galvanized iron pipe bolted under the bottom of the scow. Although the scow when working is practically stationary, and the temperature of the sea water in summer is about 75 deg. Fahr. at the surface, a vacuum of 22 in. is easily maintained.

A corrugated iron roof extends fore and aft over the drill track and the steam and exhaust pipes are secured to this. The connections to the drill cylinder and feed engine are by flexible steam hose. The fresh water tank, or hot well, is built of wood in one corner of the scow, and the powder house is located on the deck directly over it. The scow was built by day labor under the direction of the engineer in charge. The cost without the drills was about $4250.

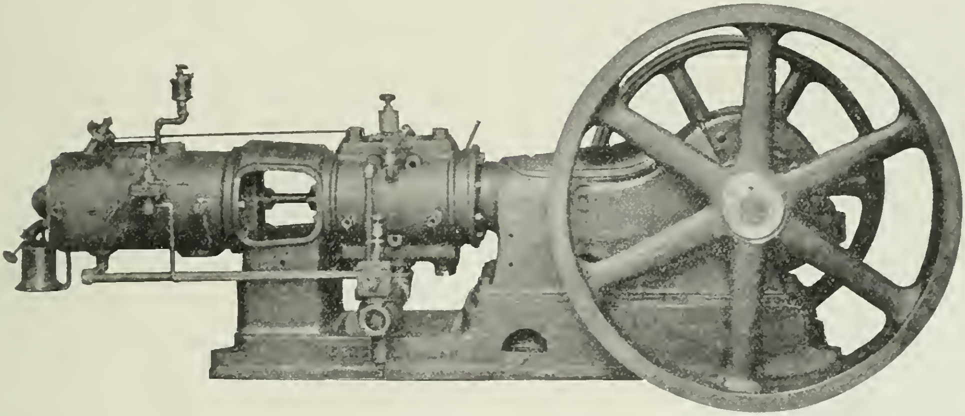
The drills, 5 in. piston, H. A. Ingersoll-Sergeant, are mounted on drill frames, lock-jointed and movable fore and aft on a steel-faced track with eyes and hook bolts for securing the frames every 5 ft. The largest drill steel used is 35 ft. and the shortest 10 ft. and about 4 lb. of blasting gelatine is used per hole.

CHARACTER OF ROCK.

The rock that has to be handled is a conglomerate of varying hardness, from an unstratified hard and close grained material (limestone) to a stratified material composed of the above with an almost sandy stratum between, the latter being probably the most difficult to deal with. Owing to the fact that there is no regularity as to this hard rock it is found to be the cheaper and more satisfactory method to locate the "humps" and charge the holes with a diver. Under ordinary conditions about eighteen holes, 7 to 8 ft. deep, have been drilled per day with one drill.

The scow has sometimes been used in the outer portion of the channel in a moderate ocean swell and has given very fair results, even under these extreme conditions. A second dredger, the "Queen Mary," has recently been added to the equipment and extensive channel improvement is on the program.

For all of the above information I am indebted to W. B. Smith, engineer in charge, St. Georges, Bermuda.—*Engineering Record.*



AN OIL ENGINE DRIVEN AIR COMPRESSOR

It may now be said that there is no mode of power generation and application which is not available for the driving of some type of air compressor built by the Ingersoll-Rand Company. The machine here illustrated, which may be said to complete the series of compressors so far as the driving is concerned, as it is designed to be driven not by gasolene, which is now becoming so costly, but by the cheaper kerosene, fuel oil or distillate, may claim the unique distinction of being operated at a lower cost per volume of air compressed than any other type of compressor in existence for which the power is artificially developed.

The air compressing portion of this machine is of the latest standard Ingersoll-Rand type designated as NE or NF, the details of which need not here be enumerated. The air cylinder as here shown is 7 inches diameter and 8 inches stroke, and at a normal speed of 325 r. p. m. will compress and deliver 66 cu. ft. of free air per minute at 100 lb. gage pressure or 73 cu. ft. at 80 lb., full allowance being made for clearance and re-expansion.

At the rear of the air cylinder a distance-piece is attached for carrying the oil engine cylinder, the air piston rod being continued into the latter. This piece serves as a standard for the end of the machine and gives a long sub-base bearing. The oil engine cylinder is completely isolated from the air cylinder, so that the air is not heated when running, and with this construction the machine may be easily taken apart and reassembled without the possibility of getting anything out of line.

The general operating design is of the "hot bulb" type, a close relation of the Diesel engine without the complication of the highly compressed air injection. A torch is provided for heating the ignition bulb preparatory to starting the engine, but after the compressor is under way the heating is self maintained. The fuel is automatically injected into the combustion chamber by means of a small pump operated by the main shaft. It enters in the form of a finely atomized spray and is immediately ignited by the hot bulb. The stroke of the fuel pump is regulated by a centrifugal governor in the flywheel, and this determines the amount of fuel injected into the cylinder, making it proportional to the load. This method of regulation is also supplemented by a regulating device on the intake of the air cylinder.

The method of operating this unit is accompanied by none of the losses common to many two-cycle gasoline engines, in which part of the incoming charge follows the exhaust gases through the outlet ports. This is due to the fact that the fuel is not vaporized by an outside agency and introduced with the air used for "scavenging;" but is injected directly into the cylinder at the end of the compression stroke. This means that pure air is used during the scavenging period of the stroke, with the result that the inlet and outlet ports can be arranged in such a way that more thorough scavenging is effected without any loss of fuel. The absence of a carbureter with its needle valves, springs and delicate adjustments, which require constant attention to suit varying atmospheric conditions is also a material advantage.

Another feature of the engine is the provision of means for inducting a small quantity of water from the cylinder jacket into the combustion chamber. This water performs the function of regulating the temperature in the cylinder, thereby preventing an undue rise in the temperature of the piston and cylinder walls, which would be liable to result in a dis-association of the fuel oil. This practice reduces the maximum pressure in the cylinder but slightly increases the mean effective pressure, making a smooth running and highly economical engine. The amount of water injected is regulated according to the load on the compressor.

The compressor as here shown occupies a floor space of 8 feet 10 inches by 2 feet 5 inches and weighs 3000 pounds. Under average operating conditions, and with the normal air output the fuel consumed is about 2.2 gallons of kerosene per hour.

Frederick Bates and Francis P. Phelps have recently published an elaborate treatise on "The Influence of Atmospheric Conditions in the Testing of Sugars." The researches in question cover a wide range of experiments. The writers assert that the question of atmospheric conditions exerting an appreciable effect in testing sugar, has been but vaguely recognized for some years. The magnitude of this influence had, however, never been determined, and they express astonishment that this possible source of error has been ignored so long when one remembers how painstaking scientists have worked to reduce the testing of sugar to an exact science.

PNEUMATIC CAISSON EXPERIENCE IN SHAFT SINKING

In an interesting article by Mr. P. B. McDonald, in a recent issue of Mining and Scientific Press, he tells of the difficulties encountered in sinking shafts which have to be driven through quicksand, the locality being among the iron mines of Michigan and Minnesota. In dealing with both the sand and the water great ingenuity is required, and the limit of mechanical resource is often apparently reached.

The pneumatic caisson is only available within certain limits, the principal one being the physical ability of the men to work in the pressures required, although the same pressures also act to prevent the caisson from sinking as required.

The Foundation Company, the article continues, does not pump water, but holds it back by compressed air. Thus, when the mining company begins sinking in rock, it may have trouble in the first few feet due to water, the iron ore being essentially an oxidized formation, and water gets through it easily. The most troublesome part of the caisson work is generally at bedrock, because sand and pebbles may grade into hardpan and broken "ledge" so gradually that it may be thought bedrock has been struck when it is in reality not solid enough to warrant sealing. That is where the Foundation Company has trouble, and where the cost per foot may be several thousand dollars. The contractors sometimes lose money, as is believed to have been the case at the Morton shaft on the Mesabi where a huge sphere of concrete was rolled on the concrete drop-shaft to force it down. The caisson method is good for quicksand, but after penetrating a stratum of quicksand if a hardpan or stiff clay stratum is cut, the work goes very slowly. The "sand-hogs" can dig only intermittently and the shaft will refuse to drop from friction on its sides.

THE SAND HOG LIMIT.

The final pressure of air used at the Rogers shaft near Iron River was about 45 lb. per sq. in., which is not far from the limit of human endurance; each man worked two 40-minute shifts per day. Men are required to be in fair health, to have a good heart and digestion, and not to be drinking, to go into compressed air. It is not dangerous to an ordinary individual, although some people get in the air-lock and when the air is turned on, decide that their constitution is not good and ask to be let out. The feeling is similar to that of being under water, and the voice sounds similar when talk is attempted. Due to the compressed air, candles several inches in diameter are necessary and even these burn very fast. Care should be taken not to allow the clothes to catch fire, as they will burn as though soaked in oil. In entering the caisson, several minutes are taken in the air-lock where the ordinary man holds his nose and blows into his ears by puffing his cheeks out; a foreman who goes in and out a half dozen times a day may just rub his hand across his nose a couple of times. Before going in, you can test the tubes between your ears and your mouth, by holding your nose and forcing air into your ears until each one "clicks," showing that the pressure is greater on the inside than on the outside of your ear drum. In the air-lock, as the compressed air gets into your system, the pressure on the inside of your eardrums becomes the same as on the outside; it is only at first that it is greater on the outside. That most painful afflication the "bends" or its worse form "paralysis," which is due to coming through the air-lock too quickly on the way out, is said to be caused by bubbles of compressed air in the blood, which should have been given time to work out by the lungs and skin when in the air-lock. "Bends" in the arms is common, paralysis in the legs is worse, and when attacked in the muscles of the stomach one generally asks a bystander to kindly hit him on the head with an axe. Men with the "bends" are taken into a hospital-lock, a steel cylinder where compressed air can be turned on and then allowed to escape very slowly. The "sand hogs" drink warm coffee before going down.

The work of "sand hogs" at the bottom of a shaft is merely to pick and shovel; the dirt is hoisted out in a bucket. A dozen men will work a shift in broken bed-rock or in hard pan, and scarcely any difference can be seen; perhaps a couple of buckets will be sent up. Man's strength seems greatly diminished in the high air pressure. To keep the compressed air from escaping through the sand, a layer of clay is sometimes plastered around the bottom of the steel shoe. In spite of that, bubbles will frequently be seen coming out of the ground a hundred feet from the shaft. It usually keeps an air compressor or two busy supplying the pressure for the caisson, as the air leaks out through the sand and the walls of the caisson. The air is let out of the caisson when it is necessary to let the concrete shaft drop down the distance that has been excavated, perhaps a couple of feet; otherwise the air pressure holds the shaft up. Of course, the men are out when this is done, as the water floods in and has to be blown out.

SUPERHEATED COMPRESSED AIR TO CURE CANCER*

"Superheated Air as a Cure for Cancer" was the subject of an address delivered the other day by Dr. Bell in the Cancer research department of the Battersea Hospital. Up to 1903 Dr. Bell relied solely and not without success upon dietetic, hygienic and therapeutic treatment. He then employed superheated air as a local application, the treatment being supplementary to his former methods. Since the Cancer research department at Battersea has been in working order it has been possible, he says, to demonstrate how the important supplementary treatment of heating up the cancerous growth operates. "The knowledge thus gained," said Dr. Bell, "is bound to prove of supreme importance, as it has placed beyond doubt the fact that the cancer cell is unable to survive if retained at a temperature of 115 deg. to 120 deg. for a few minutes at a time, the application of the heated air being repeated at intervals under a pressure of from three to four atmospheres."

[The pressure here spoken of is understood to be the pressure behind the jet of air, to give the desired impinging and penetrating effect.—Ed. C. A. M.]

"The result apparently is that the vitality of the morbid cells is gradually destroyed, these cells subsequently becoming absorbed. It must, however, be clearly understood that this result can be assured only if the disease is dealt with in the early stages of its development. Three patients have been dismissed completely cured. Therefore if in the early days of the appearance of the disease patients will consent to present themselves for treatment we may, with confidence, look forward to the time when cancer will not be looked upon as an incurable malady."

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*London Correspondence, N. Y. Sun.

THE AIR LIFT FOR OIL WELLS

A valuable paper compiled by Ralph Arnold and V. R. Garfias and recently issued by the Bureau of Mines, (Technical Paper 70) treats of Methods of Oil Recovery in California, in which the Air Lift figures prominently. This portion of the paper is here reproduced in a somewhat condensed form.

The operation of the air lift depends on the buoyancy of aerated liquids. To obtain the desired results, air is pumped into the well through a small pipe to a convenient point below the surface of the liquid, where it is allowed to discharge into a larger pipe through which the aerated fluid rises above ground. It is important that air be admitted to the fluid in a finely divided state and in such a manner as to realize the full cross-sectional area of the discharge pipe for the passage of the liquid. The pumping of water by this method has been successfully accomplished for many years and most of the experience gained with the air lift has been obtained in pumping water. It is claimed that clean oil with a gravity of about 0.8641 (32° B.) can be lifted by air almost as readily as water, but that clean oil with a gravity of 0.9589 (16° B.) or heavier generally can not be recovered economically. However, a well in the Santa Maria district, producing oil of about 0.9859 (12° B.), is said to have operated successfully with air.

The successful operation of the air lift for pumping oil and water mixtures depends upon a number of factors, most important of which are: (1) The height of the column of fluid that the aerated mixture has to overcome or the height from air inlet to the surface of liquid in the well. This is known as submergence. (2) The total vertical distance from the point of admission of air to the point of discharge, the ratio between these two quantities representing the percentage of submergence. (3) The lift or distance from the surface of the liquid to the level of discharge. (4) The air pressure. (5) The pressure of gas in the well. (6) The gravity of the oil. (7) The percentage of water in the oil. (8) The quantity of sand in the oil. This method is used extensively in the Kern River field, where conditions are very favorable for its successful operation. The wells in this field are about 1,000 feet deep and produce oil with a gravity of 0.9722 (14° B.) and containing 80 to 85 per cent. of water, the submergence in most cases being between 250 and 400 feet, or about 33 per cent.

The quantity of air should be carefully regulated, the best results being obtained with the minimum volume of air necessary to cause the liquid to flow in a constant stream. Owing to the extra pressure needed to overcome the friction and inertia, the starting pressure is about double the working and calculated air pressure. The variations in the level of the liquid in the well are indicated by pressure gages on the compressor and air side of the valve that controls the air supply.

The gas that sometimes accompanies the oil helps the action of the air lift by diminishing the required air pressure, and in order to utilize all the available gas pressure it is customary to place a packer between the tubing and the casing, thus forcing the gas to flow through the discharge pipe. Wells of the same depth may require different pressures, and in order to obtain the best results a careful study of the special conditions will be desirable. In the Kern River field, wells about 1,200 feet deep are pumped with air under a pressure of about 180 pounds to the square inch.

In most fields where the use of compressed air proves most beneficial, the oil and water occur in somewhat well-defined layers—a lower indefinite layer of water, and upper one of nearly pure oil, and an intermediate layer consisting of a mixture of oil and water. In nearly all such fields the water surface stands at a well-defined plane; below water is obtained, above the percentage of pure oil increases with the distance above this plane. It is possible, therefore, providing the necessary submergence is available, to pump either water or oil, or within limits, any combination of the two, by regulating the location of the air inlet in relation to the water surface. If air is admitted to a stratum where water and oil are mixed the churning action caused by the air has a tendency to mix them more thoroughly and to form emulsions. This result is avoided sometimes by pumping the water and oil in the same well separately, using the air lift for the water and removing the oil by means of a plunger pump.

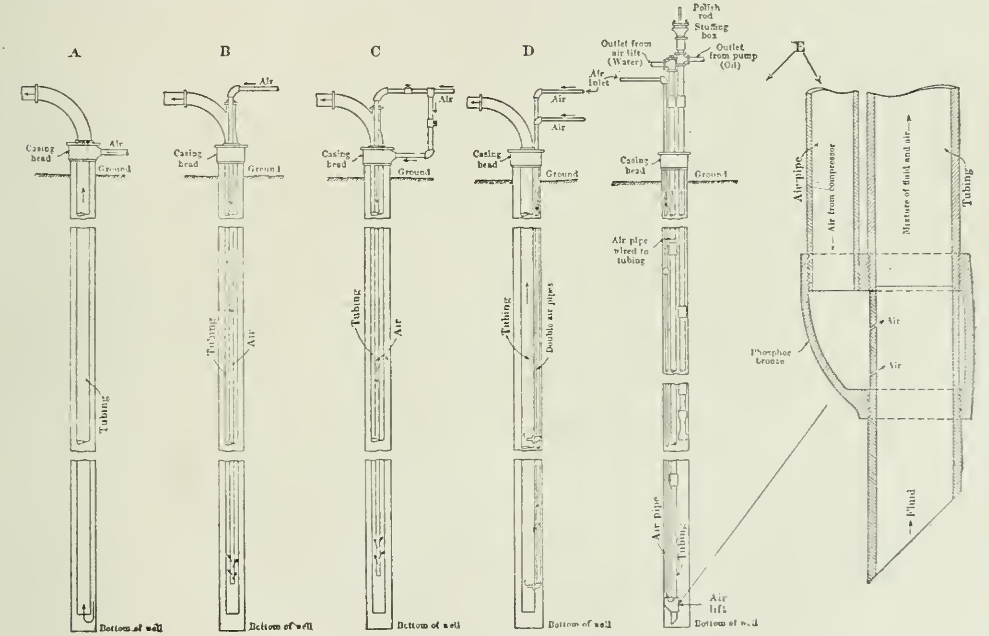
The conditions under which the use of an air-lift pump becomes advisable can be ascertained only after a careful and intelligent analysis of all factors affecting the operation of the property, and usually it will be found economical to seek the advice of a competent mechanical engineer before incurring the necessary expense for development. The high initial cost renders the selection of compressed-air machinery of special importance, and the proper choice and disposal of air lines and well tubing, the regulation of air pressures, and the proper determination of the many factors involved in power-plant economics are each problems of such importance that their solution can be best determined by a technically trained man familiar with local conditions.

In general, it may be stated that air-lift pumping in the oil fields should be used as a last resort when the ordinary methods are no longer effective, and should be restricted to territory where considerable water accompanies the oil and there is ample submergence.

OPERATION.

The different arrangements of tubing for operating the air lift are shown in the cut. A shows a lift arrangement comprising an annular air tube, and B and C show an arrangement utilizing a central air tube. In the device shown at C the operation of the air lift is regulated, and to some extent improved, by admitting air under pressure in the annular space between the casing and the tubing. The arrangement of tubing represented by D, in which two separate air pipes are used, has not proved satisfactory. At E is shown a modified type of air-lift pump used successfully in the Kern River field. The air is admitted into the discharge pipe by means of the foot piece, as shown, and pumps the water; the oil above is removed by means of the plunger pump.

In most air-lift pumping the air is conveyed into the well through a 1-inch pipe, under a pressure sufficient to overcome the weight of the column of liquid representing the submergence, and is discharged into a 2½ or 3 inch tubing through a pump head or foot piece (C), which controls the distribution of the air. As the column of liquid becomes aerated and consequently lighter, the pressure can be correspondingly reduced. This method has given satisfactory results in some properties in the Kern River field. In at least one well in the Salt Lake field two plunger pumps are utilized in similar manner, one pumping almost clear water, while the other skims the oil higher up. In some wells it may even prove practical to use two separate air lifts, one for the water and the other for the overlying oil.



AIR LIFTS FOR OIL WELLS.

When large quantities of fluid are being removed from several wells within a small area, an underground migration of oil and water toward certain wells is established, and other nearby wells may be disprived of the oil and tap only the underlying water. If large quantities of water are pumped from these "water" wells by means of the air lift, the level of the water in the immediate vicinity will be somewhat lowered and the proportion of pure oil pumped in "oil" materially increased. The operation of such water wells, sometimes known as "key" wells, has therefore a marked influence on the oil productivity of the surrounding area.

Several formulas have been derived in an effort to develop a theory of the air lift pump on a mathematical analysis of the problem, but these apply only to conditions that prevail in pumping water, and do not necessarily apply when water constitutes only a fraction of the total volume of fluid pumped. Davis and Weidner state that "by varying the percentage of submergence, and therefore the lift, the length of pump remaining constant, the maximum efficiency (pumping water) is obtained at approximately 63 per cent. submergence for all rates of input or discharge."

The data collected in the oil fields apply only to local conditions, and results are necessarily dissimilar. In some instances the best results have been obtained with a submergence of about 60 per cent. In the Kern River field it has been found that the best results are obtained with a submergence of between 30 and 40 per cent., but owing to the varying nature of the oil-and-water mixtures, and to the many local modifications necessary in operation, it is doubtful whether even future investigations will warrant a single value for this ratio. In general, when mixtures of water and oil are being pumped pipes of about 2½ inches diameter, and somewhat greater submergence than the best value for water, give the most satisfactory results.

Hutchinson states that in the Kern River field a typical well, about 1,200 feet deep, is operating with an air pressure of 182½ pounds to the square inch at the surface and a 30 per cent. submergence.

QUANTITY OF AIR.

The consumption of air varies with change of any of the conditions affecting the efficiency, such as submergence, height of lift, quality of the oil, quantity of water and sand in suspension, and volume and pressure of accompanying gas. Representative tests have shown a consumption of eleven or twelve volumes of free air to one of fluid pumped, and for less efficient operation the proportion of air to fluid may be fifteen to one, or more.

The transmission and application of energy by the use of compressed air always involves a low over-all efficiency. Between input to the compressor and net work in terms of oil lifted, the efficiency will average only about 30 per cent.

In the Kern River field, with a 35 per cent. submergence, which has proved on the whole most satisfactory, the consumption per well per minute has averaged about 140 cubic feet of free air, compressed to a pressure of 152 pounds per square inch. After estimating the theoretical required volume of air, an adequate margin of safety should be allowed in calculating the quantity of air needed in actual practice.

ADVANTAGES.

The principal advantages of the air-lift system are its great capacity, low operating cost, and low cost of upkeep at the wells from absence of moving parts, thus making it especially suited for handling oil-and-water mixtures carrying a considerable quantity of sand, which would rapidly wear valves and pump barrels.

In properties where the oil produced contains considerable water the exhaust steam from the compressor plants can be carried through pipe coils and utilized for heating the fluid to a temperature at which the water and oil will separate. This method of heating oil is inexpensive, lessens the work on the engine condensers, and saves the consumption of fuel oil needed to realize the same purpose. A temperature of 150° F. can be thus maintained in the heating plants, giving excellent results in dehydration. Certain emulsions containing 50 per cent. of water before treatment have been reduced to a point showing not over 2 per cent.

The air lift generally works in a satisfactory manner when not over 20 per cent. of sand accompanies the oil. Thompson notes that a fluid mixture containing as much as 50 per cent. of sand has been removed by the air lift. The presence of clay in suspension generally occasions much more serious trouble.

DISADVANTAGES.

Some oil operators maintain that although the use of compressed air will, beyond reasonable question, increase the production in comparatively shallow wells for a limited time, nevertheless, after a certain amount has been recovered, the oil seems to recede. This claim is seemingly substantiated by the fact that at times neighboring wells increase in production, while those operated with air decline. This condition, however, may be due to a number of factors other than the action of the air.

Another factor that limits the use of the air lift is the depth of submergence required. The extraction of mixed water and oil in large quantities from small areas lowers the water level, thus increasing the height of lift and the degree of submergence necessary to maintain a fixed percentage. The lowering of the pipe to meet these conditions must ultimately bring it to the bottom of the well, thus leaving a residue of liquid which can be removed only by an increasingly uneconomical use of the apparatus.

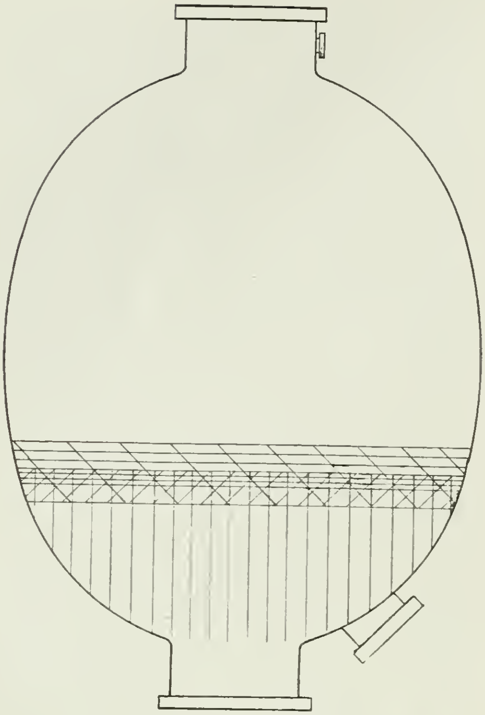
In wells in which there is not enough fluid to allow continuous operation it becomes necessary to apply the air intermittently. Such operation, however, may cause sand to run in and give serious trouble. In such cases it is generally best to use the plunger pump, say every 24 or 48 hours, and recover only the accumulated oil, an operation that is often spoken of as "skimming." The air lift is not generally satisfactory for pumping heavy, viscous oil, as the air and oil do not mix readily, and the aid escapes carrying little or no oil with it. The violent agitation of the fluid. caused by aeration, leads at times to the formation of emulsions, which are separated with difficulty. As a rule the greater part of the water and oil separates if the mixture be allowed to settle after heating, but some emulsions require either an electric treatment or partial refining in order to separate their constituents. Because of the general characteristics of air-pressure machinery and appliances, the high initial cost and the sums invested in existing installations, the use of air-lift pumping is to be considered only where the wells are numerous, not widely scattered, and not of excessive depth, and when the fluid in the wells rises high enough to provide the necessary submergence and carries a large admixture of water, but not excessive proportions of sand and clay.

USE OF COMPRESSED AIR IN ENGINES.

A special plan developed to meet peculiar conditions is now in practice in the Salt Lake field. On one property there are 52 wells, averaging 1,200 feet deep and producing oil with a gravity of 0.9655 (15° B.) and large quantities of gas. Considerable sand accompanies the oil, necessitating frequent cleaning of the wells. The boiler water contains a large percentage of incrustating solids, necessitating the cleaning of the boilers on an average of every eight days. As there is no market for the gas, the cost of fuel is a small item in the total cost of operation. The property was first operated entirely with steam, but its use became impracticable owing to the poor quality of the boiler water and the large amount of condensation that took place in the long steam lines, the wells being scattered over 500 acres of territory. It was found, however, that steam installation could be replaced advantageously by using compressed air in place of steam for the operation of the engines. This plan was adopted and has been in successful operation for about two years. The air is compressed to a pressure of 38 pounds per square inch in three 1600-foot per minute, steam-driven, condensing, cross-compound, single-stage, duplex air compressors, and is reheated at the wells to a temperature of about 200° F. by means of a small burner using natural gas as fuel. As steam was necessary to operate the engines for drilling or cleaning the wells, and for heating oil for its separation from water, all the steam equipment was retained. Much of the boiler trouble has been eliminated by using condensed water from the compressors, it being estimated that 24 wells are now pumped with the same boiler that formerly handled 10.

TUNNEL ACCIDENTS

Bulletin 57, issued by the U. S. Bureau of Mines, tells us that tunnel accidents in sixteen important works have averaged 4.7 deaths annually and nearly three times as many serious and thirteen times as many slight injuries per thousand men employed. While most of the accidents were caused by ore or rock falling from the roof or walls of the tunnel, many of them were the result of ignorance or gross carelessness and could have been avoided. Many of them occurred from the improper use of explosives. To reduce the number of accidents it was recommended that roof blasts should be made with as small charges of explosives as practicable; that men be detailed to remove loose pieces of roof immediately after the blast; that each man carefully inspect the roof under which he works; and that any doubtful piece of rock be tested by impact, and if vibrations can be detected by touch or through a stick, the rock be immediately removed.



WOOD PULP COOKER.

A NOVEL USE FOR THE SAND RAMMER

The pneumatic sand rammer is now employed, especially in England and Germany, for packing the wooden chips and allied materials in the large steam cookers in celluloid factories. These cookers or digesters, see sketch, are normally egg shaped and of great size, say from 20 to 80 ft. high, with other dimensions in proportion. The loose chips are first dumped in to a depth of 10 or 12 ft., and then a man is lowered through the central opening in a suspended chair and he keeps going over the mass with a sand rammer until it is packed down to a height of 3 ft. or so. Then another large quantity is dumped in which is rammed in the same way, and so on until the vessel is entirely filled.

The cover is then secured and steam is admitted and continued under a certain pressure for a certain period. The small side opening at the top permits a sufficient discharge of air to secure an effective circulation of the steam. Some judgment is required in the use of the rammer as it is possible to pack the material so tightly as to render it impermeable to the steam. The sand rammer in this service is not only a great time and labor saver. but also does the work in a much more satisfactory manner.

VACUUM DEVICE FOR FILLING A LARGE BALING TANK

At the Daggafontein Gold Mining Company's property on the extreme southeastern Witwatersrand sinking is proceeding as rapidly as circumstances will permit, but operations have of late been much hampered by the presence of hard dyke rock and the influx of large quantities of water. An ingenious vacuum baling tank is now being installed to bale out water from the shaft. For the following particulars of this device, we are indebted to Mr. J. M. Martyn, the manager of the Daggafontein G. M. Co. An air-pump for creating a vacuum is being placed 300 feet above the bottom of the shaft. This air-pump is to be driven by a Pelton wheel, and the head of water is 500 feet, the displacement of air in the pipes being equal in area to the displacement of air in the tank. Four-inch diameter pipes are carried down to within 40 feet of the shaft bottom; at the end of 4-inch pipes a 40 feet length of flexible hose is attached. A four-inch diameter pipe is carried up to within an inch of the tank top, the lower end of the pipe coming through the side of the tank, which carries a vacuum brake connection coupling. A leather-faced valve operates on a seat connected to a valve spindle and fitted with a ball-joint at the top of the valve, the spindle working through guides The seat, on which the valve operates is raised five inches above the bottom of the tank, with turned face to prevent leakage, the seat being bolted to tank bottom and the top-heads of bolts counter-sunk. An eight-inch diameter valve is connected to the side of the tank and is operated at the top of the tank, the spindle of the valve passing through a stuffing gland: this valve is fixed in the tank to provide for emptying the tank at the side if required. An air-tap, one-inch diameter, is fixed on the top of the tank to admit air at atmospheric pressure the moment the tank is being emptied. Fixed on the side of the tank is a gauge glass to indicate when the tank is full, the gauge glass is protected by ribs of iron. A man-door is fixed on the centre of the tank to admit of repairs to valves, etc. A perforated plate with wire mesh cover is fixed over the valve orifice at the bottom of the tank to prevent small stones from getting in between valve face and seat. The end of the flexible hose leading down from the vacuum pump is fitted with a corresponding half vacuum brake coupling with a stop-cock immediately above. When the tank arrives at the bottom of shaft it is guided into the water sump, the eight-inch diameter spill valve and one-inch air tap at top of tank being closed. The vacuum brake coupling at the end of flexible hose and the corresponding half on the tank are instantly attached and the stop-cock opened. The air in the tank being immediately exhausted, the tank fills in 15 seconds through the twelve-inch valve at the bottom of the tank. The stop-cock is shut when the gauge glass indicates that the tank is full, and the vacuum couplings are detached when the tank is free to ascend the shaft.—*South African Mining Journal.*

SHEEP CREEK TUNNEL

We present here a brief, but interesting discussion of the machines and methods used to drive the Sheep Creek tunnel of the Alaska Gastineau near Juneau, Alaska. The information comes originally from the mining company itself.

From Dec. 1, 1912, to Feb. 1, 1914, a period of 14 months, the tunnel was driven 7670 ft., an average speed of 548 ft. per month. The equipment and routine during this period were not changed.

The tunnel or adit is 8½x10½ ft. in section, driven along the general strike of the formation, a short distance on the foot-wall side of the contact of the ore zone with the country rock. The character of the ground varied a good deal. The first 2000 ft. approximately was in a tight, closely laminated slate, the remainder was through greenstone and metagabbro. The ground was all hard and tough; the best footage was made in greenstone. The monthly record was made in November, 1913, when 661 ft. was driven.

Three crews of men were employed. Each crew worked 6 hours and rested 12 hours. This resulted in a complete cycle of operations every three days. Considered by days, the average working time per day for each crew was eight hours; this was the time at the face, as the incoming shift always relieved the outgoing at the working place. Each crew consisted of a shift boss, eight machinemen, six muckers, one carman, one motorman and one brakeman; three men were also employed on the compressed-air and ventilating pipes, the ditch and the floor.

Drilling was carried on with E-44, 3¼-in. Ingersoll-Rand machines on two horizontal bars, 4½ in. by 9 ft. The compressed air was obtained at 105 lb. from an Ingersoll-Rand 22- and 13x16-in. machine of the Imperial type driven by a General Electric 200-hp. motor. Half of the compressed-air line was of 7-in. casing and the other half of standard pipe.

Ventilation was furnished by four high-speed exhaust fans driven by General Electric form K, 20-hp. induction motors running at a speed of 1740 r.p.m. These were spaced about 3000 ft. in the tunnel and were operated as exhaust machine, delivering the exhausted air into a ventilating pipe, 15 in. in diameter, of 18-gage galvanized iron.

The cars used were 1½-ton side dumpers with roller bearings; they were handled with a 6-ton Jeffrey storage-battery locomotive. The track was of 24-in. gage, laid with 50-lb. rails. There were no switches installed, but at certain intervals iron slick-sheets were laid alongside the track and the cars were transferred to them by the carman using a crowbar. A false track, 25 ft. long was placed over the rail ends when needed to keep the cars up to the muck pile.

A 1-in. water line was kept well up to the face and water was used to wash down the muck pile at once after blasting, in order to kill the gas. The drills were sharpened with a No. 5 Ingersoll-Rand sharpener; about 600 pieces of steel per day were used.—*Eng. and Min. Journal.*

A LIFE-LINE GUN

Among the various equipment of the New York fire department is a life-line gun. From this gun a line fitted with a plug or harpoon, much the same as that used by the life savers of the sea and in the whaler's cannon, is fired. Because of the great accuracy and dependability required in this branch of the life savers' work, an especially equipped .44 cal. Remington is used to fire the life line. At times, it is necessary to shoot this line into a window several stories from the ground or over the roofs of buildings. A very light carrier line is used, but to this line is attached a heavier line capable of carrying enormous weights. The heavy line is easily pulled up and made fast, when the well trained fireman is able to slide down with the rescued person.

THE DEEP MINES OF THE RAND

The Village Deep Mine at the end of the year had been opened up to a depth of nearly 200 feet below the plane of the 21st level. At the present time a maximum working depth of about 4,500 feet has been reached in this property, the depth of the Turf Mines shaft being 4,200 feet, and the work carried out below the bottom of this shaft representing in vertical depth a further 300 feet.

SOME ULTRA-DEEP MINES.

The Village Deep is thus the deepest mine at work on the Central Witwatersrand, and now that operations in the Jupiter and Cinderella Consolidated have been suspended, it is the second deepest proposition of the Main Reef series, the Simmer Deep holding pride of place in this regard. The deepest of all the mines on the Rand, whether working or idle, is the Jupiter, where a vertical depth of well over 5,000 feet has been reached. The Jupiter and the New Chum Railway Mine, in the State of Victoria, are thus, in all probability, the deepest gold mines in the world.

QUESTIONS OF VALUES AND COSTS.

In the earlier days of these fields, when the flotation of deep level properties was inaugurated, it was repeatedly urged that the increased depth of working would be attended by higher operating costs, and in fact that working expenses would increase in more or less direct ratio to the increase in working depth. One of the principal difficulties which it was in those days supposed would militate against working at great depth was the hoisting of ore and the lowering and hoisting of men and tools. Pumping it was considered would not present any serious difficulties, and although it was rightly deemed there would be increasing loss in transmission of compressed air as greater depths were reached, it was not thought that the operation of underground rock drills either would present many obstacles. It is in connection with hoisting and lowering that difficulties which a dozen years ago were regarded as very serious have been most easily brushed aside. Electric stage hoisting has rendered raising of rock from a depth of about three-quarters of a mile surprisingly easy, and it is very evident to-day that the scale of working and whether sufficient or insufficient labor is available are the factors that determine the cost of working rather than the depth at which ore winning operations are conducted.

SCALE OF WORKING THE CHIEF FACTOR.

To return to the Village Deep in illustration of this statement, it may be pointed out that the cost of operation on the basis of a ton milled for this proposition in March was 15s 7d. per ton, exclusive of development charges, or with development costs 17s. 2d., as against an average of 17s. 3d. for the whole Witwatersrand. The statistics relative to the Simmer Deep Company's operations in March bring out the point even more clearly. At this mine the total cost of working, including development or development redemption charges was 14s. 3d. per ton, or 3s. per ton below the average for the whole field. These figures certainly entitle one to be hopeful as to the probable results of working banket down to a depth of 7,500 feet, provided circumstances in regard to labor, etc., favorable to operation on a large scale, and that healthy working conditions can be maintained down to this depth —*South African Mining Journal.*

PROGRESS OF THE GREAT NEW ZEALAND TUNNEL

Mr. S. B. McQuade, Melbourne, Australia, sends us the latest account of the work on the Arthur's Pass tunnel from Otira to Bealey, New Zealand, which has been mentioned from time to time in our pages. This must rank as one of the great tunnel enterprises of the age, it being 5⅓ miles long and driven entirely from the ends. As there is a grade of 1 to 33 it is difficult and costly to keep the upper end drained, so that the work is pushed more rapidly and constantly from Otira the lower end

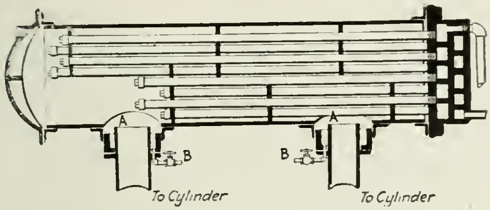
There has been much speculation, says our account, as to when the Otira tunnel will be completed, but most of the views expressed have been too optimistic, for at the present rate of progress it will be fully another five years before this great undertaking is finished. The work has now been in hand well over six years.

The following are the correct chainages of work done from the Otira end to the end of the last week of April:—Bottom heading, 2 miles 22 chains 57 links; top heading (known as No. 8 break-up), 2 miles 6 chains 35 links; walls, 2 miles 2 chains 8 links; lining, 2 miles 1 chain 6 links.

Great things were expected when hammer

drills were installed at the face in the bottom heading in place of the piston drills which had been used previously. While not giving the return that was expected of them the hammer drills are far superior to the piston drills and show up to advantage in hard, heady ground; also there are not so many lost holes.

The progress that is being made is much the same as usual, although the last two weeks have been above the average. Preparations are being made to instal a blower inside the tunnel for ventilation purposes, as the present blower at the tunnel portals has reached its limit. A compressed-air-driven drill sharpener has been installed, which is a great improvement upon the old way of sharpening.



NEGLECTED INTERCOOLER.

LOCATING THE TROUBLE IN AN AIR COMPRESSOR

BY T. G. THURSTON.

A large two-stage, cross-compound air compressor, the discharge pressure being 120 lb. and the receiver or intercooler pressure normally about 30 lb., was hurriedly installed. For a few weeks it ran well, then a knock developed in the high-pressure cylinder. The knock came at irregular intervals and the receiver pressure began to gradually increase week by week.

When the high-pressure discharge and inlet valves were taken out they were corroded and badly gummed, and a large amount of grit and dirt had accumulated on them and in the discharge ports.

The valves and ports were cleaned, the valves replaced, and upon starting the compressor worked a little better, although the receiver pressure did not come down to where it should. A few days later the knock again announced itself and the receiver pressure gradually increased to 60 lb.

The low-pressure journal bearings pounded badly, due to the excessive receiver pressure. Then the high-pressure cylinder was opened and the piston taken out. A piece about 3 in. long was found broken out of each ring and the rings were worn down to 1/8 in. in places. The air passages from the discharge side were filled with a gritty, gummy substance resembling brick dust mixed with oil, and some of it was baked quite hard.

The intercooler was placed horizontally across the two air cylinders, as shown in the illustration. Much water accumulated and found its way into the pockets *AA*, around the air passages leading to the air cylinders. These were provided with pipes and valves for drawing the water off regularly, but this had not been done as often as necessary, and, consequently, the water got into the high-pressure cylinder. Added to this, the air had been taken from the basement directly under the compressor, which was damp and full of dust from the construction work going on.

Two new rings were made for the piston, the air intake was piped to the roof and a trap connected to the two pipes *BB* to insure the water being taken away as fast as formed. When the compressor was started the receiver pressure showed only 27 lb., and the machine ran quietly and has not caused any further trouble.—*Power.*

FREE WATER IN THE PHILIPPINES

A feature which would be unique anywhere else in the world but is common enough in certain locations in the Philippine Islands is the copious supply of excellent artesian waters flowing freely along the highways. The traveler has no need to trouble the housewife for a drink of water, nor the cantina nor the hotel, neither will he find it necessary to trespass upon private property to reach water. The Bureau of Public Works has drilled hundreds of these wells, and several of the provinces have purchased well-drilling machines in order to extend the well system more rapidly. Nearly every town has several of these wells and generally one may be observed at the roadside every few minutes as the traveler passes along. The water is pathogenically pure, clear, sparkling, cool and flowing, which conditions are a natural sequence after the waters have fallen upon the distant and forest-covered sierra, and have percolated for miles through the porous stratum to the perforation made by the bit of the well-drilling machine. Thus, it may be observed that ample facilities to obtain potable water exist for man and animal, and for motor cooling.

FILTRAS

This is a new filtering medium promising to be of great value. The standard Filtras tile is 12 by 12 by 1½ in., but it can be produced in various shapes and sizes. The material is essentially silica; it easily stands any temperature up to 1600F., is practically unaffected by acids or by such weak alkalies as are in use where filtration is required. The ware is white and porous, of excellent hardness and strength and may be made in various degrees of porosity. Normally the pores are so fine as to offer great resistance to the penetration of even the finest slimes, yet the mass is itself so porous as to allow comparatively free passage of gases or liquids to be filtered.

The remarkable uniformity in the porosity of the tile is to be noticed, particularly important as this is in problems involving aeration and agitation. The following data of air rating tests will give an indication as to this porosity. These show the number of cubic feet of air per minute per square foot of area that at the low pressures given passes through. the standard tile 1½ in. thick.

	Cu. Ft. of Air at 2-In. Water Pressure.	Cu. Ft. of Air at 4-In. Water Pressure.
Specimen 1..	12.0	24.5
Specimen 2..	11.7	22.8
Specimen 3..	11.4	22.7
Specimen 4..	11.7	22.7
Specimen 5..	12.0	23.0

DUST AND BACTERIA IN THE AIR

At the Woolworth building, in New York, the air at the street level on July 2, 1913, contained 221,000 dust particles per cubic foot; at the tenth story, 85,000; at the thirtieth story, 70,000, and at the fifty-seventh story, 27,000. As a figure of comparison, the air over Long Island Sound at a point several miles from shore, was found to contain 18,000 dust particles per cubic foot.

At the John Hancock building in Boston on June 5, 1913, the air near the sidewalk contained 1,330 bacteria and 20 molds per cubic foot, while at the tenth story the corresponding numbers were 330 bacteria and 3 molds per cubic foot. The elimination of the horse from city streets is helping to reduce the organic dust, but the automobile is itself a dust-creator when used on road surfaces not adapted to its weight and speed.

HE TOOK CHANCES AND CHANCE TOOK HIM

BY BERTON BRALEY.

Here lies Antonio Herrowitz,
Or what is left of him.
He was a man of splendid build,
Of vigor and of vim.

He never feared to take a chance,
Wherever he might be;
He'd take a chance the roof was safe,
He would not look to see.

He'd use a drill to tamp a charge,
And take a chance on that;
He'd smoke in any gassy place
He happened to be at,

And when he rode upon the cage
He would not grasp the bar;
He never looked upon the board
Where rules of safety are,

But, being full of health and strength,
And quite devoid of fear,
He played at hide and seek with death,
And now he's lying here.

He took a chance with dynamite,
He took a chance with damp,
And in the very prime of life
Fate snuffed his miner's lamp.

He's done with taking chances now,
He's done with mines and such,
And what is left of him lies here;
He took one chance too much.

—*Coal Age.*

For switching purposes at the Cleveland ore docks, with a view to avoiding the inclusion of the switching engine among the cars being moved, the Pennsylvania Railroad has introduced locomotives which have the peculiarity that they do not run on the same lines as the cars they handle, but on narrow gauge parallel lines. Each engine has an arm on each side which can be lowered by means of compressed air controlled from the cab, and acts as a pusher. The locomotives are of Baldwin-Westinghouse make and are 25 tons in weight. Power is obtained from two rails lying inside the rails on which the locomotives operate; these rails are protected by a wood covering.

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A NOVEL AND UNIQUE TUNNEL RECORD

The account given elsewhere in the present issue of Compressed Air Magazine of the driving of the Spearfish Creek tunnel of the Homestake Mining Company calls attention again to the entire incomparability of different tunnel driving records as conclusive evidence upon any question of efficiency of performance. The conditions differ in so many cases from those of other apparently similar undertakings that when comparisons are attempted there are always factors which can be cited for excuse or apology if required.

The tunnel here spoken of was not a railroad tunnel nor up to the usual cross section dimensions with which we are most familiar, although a tunnel in which three men could walk comfortably abreast, with a yard of head room to spare, before the concreting, is not unworthy of consideration.

The record made in this tunnel, considering the headings individually, will not be cited as a time or speed record, although who can tell us of another tunnel more than four miles long holed through in a little more than a year? Time was apparently not so imperative a consideration in this case, if only the tunnel or flume was ready when the other details of the water power installation were completed. The conditions under which the work was done must be regarded as unusually favorable There was practically no hoisting required anywhere on the job nor even power haulage. All material and supplies were delivered with comparatively slight cost precisely where and how convenience dictated, and there were convenient dumps on the level for all the spoil removed. The rock was so solid that little timbering was required, and there was little trouble about water and little expense for removing it.

Electric current was readily available for the work at slight cost, thus almost compelling the adoption of this means of power transmission, yet, curiously enough, it is to this circumstance that the unique and remarkable record made is to be attributed, and it is a fortunate circumstance that the data regarding the power consumption are so complete and indisputable. The horsepower used rarely exceeded 30, and averaged below that. For the driving of sixteen headings, with drills and blowers and some pumping, ten times this amount of power, or even more than that, would have been the familiar figure.

Here surely is a world record for power consumption as compared with accomplishment in this line of work, and with so little margin left for possible future power saving in tunnel work it may be considered a record likely to stand unrivaled for all time.

This great actual saving of power, and therefore of power cost, is an important item in making up the cost of the entire work, and it is to be regretted that we could not have been favored with detailed figures on this point also. It is apparently quite probable that in total cost also a record was made, but in this particular comparisons with the costs of other enterprises would have been more difficult. At any rate the record made and indisputably recorded in this case deserves to be studied as to the means and methods employed, and these should find favor in future work of the kind. Power especially is an important item in many cases and a saving in that brings other savings in its train.

PNEUMATIC MINE TRACTION

In the June issue of Compressed Air Magazine we reprinted from Iron and Coal Trade Review an enthusiastically written account of the use of high pressure, triple expansion pneumatic locomotives in European coal mines. It will be remembered that quite extravagant claims were made by the writer as to the economy and efficiency of the system described. The article was in fact written in the spirit of a boy with a new toy and the editor without leaving his desk accepted the story at its face value and without the discounts which are so imperative in such a case.

The new toy feature just alluded to seems to have been especially pronounced in this case. It must be evident that the system so lauded has not yet passed the time test, since the developments spoken of have occurred within a couple of years. The high initial cost of plant, the corresponding maintenance cost, the reliability and safety risks of five stage compressors, excessively high storage pressure and triple expansion locomotives may mark a transition or tentative system rather than one that is finally and generally to be adopted.

For instance, according to the story, the Europeans seem to have discovered the use of compound locomotive cylinders with atmospheric inter-heaters just four years ago, while an American inventor applied for a patent for the same arrangement ten years ago. The possible values of the extremes now exhibited in European practice have been investigated and a mean has been established in this country which is proving highly satisfactory.

THE INTERNATIONAL ENGINEERING CONGRESS AT SAN FRANCISCO IN 1915

The Panama-Pacific International Exposition, from the twentieth to the twenty-fifth of September, 1915, will be the meeting place of a large body of distinguished engineers. The assemblage, to be known as the International Engineering Congress, will be presided over by Col. George W. Goethals, who has accepted the office of honorary president. Thousands of civil, mining, mechanical, marine and military engineers and naval architects, from many different nations and representing hundreds of affiliated bodies, have declared their intention of attending the congress. It is to be conducted under the auspices of five national associations, viz.: the American Society of Civil Engineers, The American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers, assisted by a committee of distinguished engineers of California.

COMPRESSOR INSTALLATION FOR FIRE ALARM WHISTLE

We have received a number of inquiries concerning the use of compressed air for fire alarm whistles. The National Electric Light Association Bulletin for June gives some information in this line, the most prominent item being the following from A. F. Nelson, Edison Electric Illuminating Company, Brockton, Mass.

This company, he says, has a compressed air system, electrically operated, for blowing a whistle fire alarm in a town of 6000 inhabitants. The service, 220 volt, is supplied through a Westinghouse, Type J, Form I, traction brake governor to a Wagner single-phase, 208 volt, 1650 rpm., 7½ hp. motor, gear connected to a 6 in. by 6 in. Ingersoll-Rand, Class E, compressor. The air is stored in three 10 ft. by 4 ft. cylindrical tanks at 100 lb. pressure.

There is a 2½ in. pipe leading to the whistle on the roof. The whistle is operated by a Gamewell whistle machine. Outside the building the pipe and valve to the whistle are boxed in, clear up to the base of the whistle, and a steam coil is placed inside this box to keep the piping and valve from freezing. This system has been installed seven years and works well. The pump has had an average consumption of a little less than 2000 kw.-hr. per year.

HIGH ECONOMY IN AUTOMATIC CONTROL

Agitation plants, pulsating jigs and other apparatus, which have recently become features of modern concentrating mills and cyanide plants, have led to the installation of separate compressors especially adapted to the purpose. These are now commonly motor driven and include provision for automatic control which enables the compressor to be started up when air is needed and shut down as soon as the volume of air in the receiving system, and consequently the air pressure, has reached a pre-determined limit. These compressors take very little power, as they are only using current when air is needed and they have proved to be extremely economical both in operation and upkeep.

FIRST DISCOVERY OF COAL IN AMERICA

Joliet and Marquette in the year 1673 returning from their tour of exploration in search of the Mississippi or as it was then known "The Great River," came up the Illinois river on their way to what is now Chicago. When in the vicinity of the present city of Utica, they discovered an exposed outcrop of seam No. 2 and were also informed by the Indians that the "stones" would burn.

There is some question regarding the exact location of the exposure of the seam, whether it was east or west of Utica. It of course was not at that place because the great La Salle anticline which brings the St. Peters sandstone to the surface, as exemplified by Starved Rock, had raised the coal seam to a considerable elevation and so exposed it to the eroding influences that it was entirely worn away over a considerable area. This resulted in an outcropping to the west near La Salle and another east of Utica, and it was one of these croppings that Joliet and Marquette observed.

Seam No. 2, also known in the north as the Third Vein and in the south as the Big Muddy and New Kentucky coal, is the only seam in Illinois that has been traced for a considerable distance by geological evidence only.

THE AIR TOWEL

Agitation for the suppression of the roller or common towel for public use has swept over the entire country, as it is considered a menace to public health. Shortly after the elimination of the public drinking cup by all authorities, the crusade on the common towel in public places started, and some ten months ago Massachusetts, Ohio, and Michigan passed laws prohibiting its use; since then more than thirty States have made similar laws. The common towel was succeeded by the paper towel, the use of which requires, besides the initial expense of the towels, an attendant to supply fresh and remove soiled and wet towels from the lavatories; now the last word in economical and sanitary innovations is the "air towel" used in the large public lavatory in the District Building at Washington, D. C. This "air towel," or electric hand drier, is the invention of J. M. Ward, superintendent of the District Building. In appearance it resembles a rectangular box 11 by 13 inches set on a sanitary base having 12-inch legs, with an opening in the top of the case in which the wet hands are held while being dried. The device consists of a blower that forces air through an electric heating element to ducts and deflectors suitably placed for distributing the warmed air to all parts of the hands at the same time, and is operated by a foot lever or pedal, which in turn operates a quick-acting switch, thereby setting the blower in motion; by removing the foot the device is put out of operation; the hands come in contact with no part of the device, thus assuring a perfectly sanitary operation. It takes just 30 seconds to dry the hands, and although this seems long while standing with the hands in the drier and practically unoccupied, tests have shown that the ordinary operation of drying the hands with a towel consumes more time if the hands are to be dried as thoroughly as by the electrical drier. Being dried perfectly there is no unpleasant sensation.—*Scientific American.*

NOTES

W. R. Grace & Co., of New York, have purchased of the F. M. Davis Iron Works of Denver a portable three-stamp mill for exportation to the mountains of Bolivia. The mill is sectionalized for muleback transportation.

The horse power required for pressure blowers capable of supplying 100,000 cu. ft. of air per minute in a mine, at a pressure of 12 oz plus the power required to overcome friction in pipes, is 600 to 650 hp., depending upon the length of the pipes.

A miniature of the Panama Canal, built on a scale of 6½ ft. to the mile, is to be operated at San Diego, Cal., during the exposition next year. A contract for constructing the model has been awarded. The cost is estimated at no less than $250,000.

To feed an average of 800 natives at the Lonely Reef mine in Rhodesia, in 1913, with bread, beans, mealies (corn), monkey nuts, rice, green vegetables, rations, salt, meat, sugar, cocoa, kaffir corn, milk, and maizena, cost a total of $36,500, equal to about $46 per head per year.

The total lift through locks of the Barge Canal is 16 times that of the Panama Canal, and it has 10 times the number of dams, 14 times as many locks, and 20 times as many structures. The cost, as far as construction and engineering are concerned, will be within the estimates, this, perhaps, being the greatest wonder of all.

The House at Washington unanimously approved the item in the sundry civil bill appropriating $150,000 to start the work on the new Bureau of Mines buildings in Pittsburgh. The total authorization for the work is $500,000, the remaining $350,000 to be appropriated at the short session in December should the money be needed.

So little is refrigeration needed in Ireland that the entire ice supply of the south and west portion of the Emerald Isle is manufactured by a single establishment in Cork, and amounts to only six tons per day. In addition to this there are two breweries, a chilled meat concern, and a butter factory with perhaps one or two other individual firms which have their own separate ice-making plants.

A black bug or beetle, locally called the slag-bug, is found around the Montana smelters in the summer, and its favorite place of attack is the back of the neck of the smelterman, where its nip or pinch causes some discomfort and strong language. A similar insect is found at Kalgoorlie, Western Australia, where it delights in diving into heaps of hot ash from boilers and roasting furnaces. It also nips hard and goes under the name of slag bettle, asbestos beetle, or salamander.

What is claimed to be the largest air compressor so far employed in the coal-mining industry of Germany has been completed by the Frankfurter Maschinenbau Gesellschaft (Pokorny and Wittekind), of Frankfort-am-Main, for the Werne Collieries of the Georgs Marienhütte Gesellschaft. The machine, which runs at a speed of 82 revolutions per minute, compressing to eight atmospheres, has a capacity of over 10,000 cu. ft. of free air per minute.

The Hohenzollern Canal, opened on June 17 by the German Emperor, and which joins the rivers Oder and Spree, brings Berlin, the German capital, into water communication with Stettin and the Baltic Sea, 150 miles away. The completion of this canal, the history of which dates back to 1669, marks an epoch in the development of German inland waterways that radiate in every direction and solve the problem of cheap transportation in Germany.

George D. Whitcomb, an inventor of mining machines and founder of the George D. Whitcomb Co., of Rochelle, Ill., died in California on the 21st ult., in his 80th year. He retired from business several years ago. He developed the Harrison mining machine, the first successful machine of the puncher type put on the market, and later organized a company to exploit his invention. Mr. Whitcomb was a coal operator before engaging in the manufacture of mining machines and was well known to the older generation of coal men.

An installation of Humphrey pumps has been ordered by the Egyptian Government for the drainage of Lake Mareotis at Mex, near Alexandria. When completed, this plant will be one of the largest pumping installations in the world, and will consist of 18 pumps, each capable of delivering 120,000,000 gal. per day through a lift of 20 ft. The combustion chamber of the pumps will have a maximum internal diameter of 8 ft. 8 in., and its height will be about 14 ft. The water valve box will be 8 ft. 8 in. diameter and 7 ft. high, and will be fitted with 100 valves of the hinge type.

The coal fields of Northumberland and Durham counties claim to be the oldest in production of any coal fields in England. It is a historical fact that these fields have been worked for at least 700 years. Every kind of coal, with the exception of anthracite, is found in these two counties. It is estimated that one-tenth of the population of Durham county is connected, in some capacity, with that industry, and that the county's output of coal in 1913 was valued at $100,000,000. There are nearly 500 coal mines in these two counties, and in 1913 there were shipped in coastwise and foreign vessels 30,791,687 tons. Of this amount Newcastle shipped practically one-half, or 15,095,055 tons.

The danger of the carbide lamp as a source of accident is not wholly appreciated. While less likely to be the cause of an underground fire than is the candle, it is also capable of inflicting more or less serious accidents by itself. Thus, in the March *Safety First*, of the Nevada Consolidated, two minor accidents attributable to carbide are described. In one case, a man was changing carbide in his lamp after dark near an open light when the generated gas exploded and burned his face. In the other case, a quantity of spent carbide was emptied where a leak in a pipe line had made a puddle of water. A laborer threw a rail from his shoulder into the puddle and the mud of exhausted carbide, practically hydrate, was splashed in his face and injured his eyes severely.

It is estimated that there are fully 50,000 amateur wireless telegraph operators "butting in" all along the Atlantic coast, and when there is a large group of them in any one place they drown out the long-distance over-sea messages. In fact, this has got to be such a nuisance that regular operators can't count on long-distance work until after midnight when the air becomes clear. Besides being a bother, this promiscuous sending of messages where practical jokers are included may become a positive menace, for if a fake distress signal is sent out there is no way to prove it's a fake.

At Czuchow, in the coal field of Upper Silesia, is the deepest well in the world. It has reached a depth of over 7,348 ft., a trifle under a mile and a half below the surface. America has three wells ranking next in order. That near McDonald, Pa., some 10 miles southeast of Pittsburgh, is 6,860 ft. deep; one in Putnam Heights, Conn., is 6,004 ft. deep, and one now being bored at Derrick City, Pa., has reached the depth of 5,820 ft. Although each of these wells is over a mile in depth, little that is new in geologic formation has been learned from the borings.

The mass of the sun is 332,800 times the mass of the earth, the respective diameters being 865,000 and 7918 miles. A body weighing 100 lb. on the earth's surface, would be about 3000 lb. on the sun. Think of going fishing there and having to lug home a basket of sunfish.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 2.

1,098,389. APPARATUS FOR WASHING SMOKE, AIR, AND OTHER GASES. GEORGE LISTER, Tow Law, England.

1,098,406. MEANS FOR USE IN STARTING INTERNAL - COMBUSTION ENGINES OF AUTOMOBILES. ALFRED ARNOLD REMINGTON and ARTHUR JOHN ROWLEDGE, Birmingham, England.

1. In a four-stroke cycle internal combustion automobile engine having not less than four cylinders, a receiver into which compressed air is admitted from a suitable source, air distributing valves which correspond in number to the motor cylinders of the engine, cams for operating the said distributing valves in turn and themselves carried by a shaft which revolves at half speed of the engine, and means, operable entirely independently of any portion of the main valve mechanism, in position between the starting cams and the valves, by which, at will, the cams and said distributing valves may be put into and out of operative relation to one another, respectively, leaving the valves closed when the cams are out of operative relation thereto, for the purpose set forth.

1,098,440. ROTARY BLOWER. GEORGE C. HICKS, JR., and RALPH C. ENTYART, Connersville, Ind.

1,098,448. ENGINE - STARTER. HENRY M. KINSLOW, Santa Ana, Cal.

1,098,453. FEEDER-BELLOWS. FRANK G. LYNDE, Newark, N. J.

1,098,474. MACHINE FOR MAKING AND SHARPENING ROCK-DRILLS AND FOR GENERAL FORGING. Carl Brown, Denver, Colo.

1,098,494. PNEUMATIC CLOCK MECHANISM. Augustus T. Hahl, Chicago, Ill.

1,098,506. AIR-DRYING APPARATUS. Samuel H. Kelm, Salem, Ill.

1,098,585. FLUID DOOR-CONTROLLER. Edward N. Mills, San Francisco, Cal.

1,098,616. PRESSURE-REGULATOR. John L. Creveling, New York, N. Y.

1,098,633. AIR-PUMP. Vernon H. Meyer, Cleveland, Ohio.

1,098,690. DRILL. Mather W. Sherwood, Franklin, Pa.

1,099,141. VACUUM CLEANING-TOOL. Eugene M. Kent, Rome, N. Y.

JUNE 9.

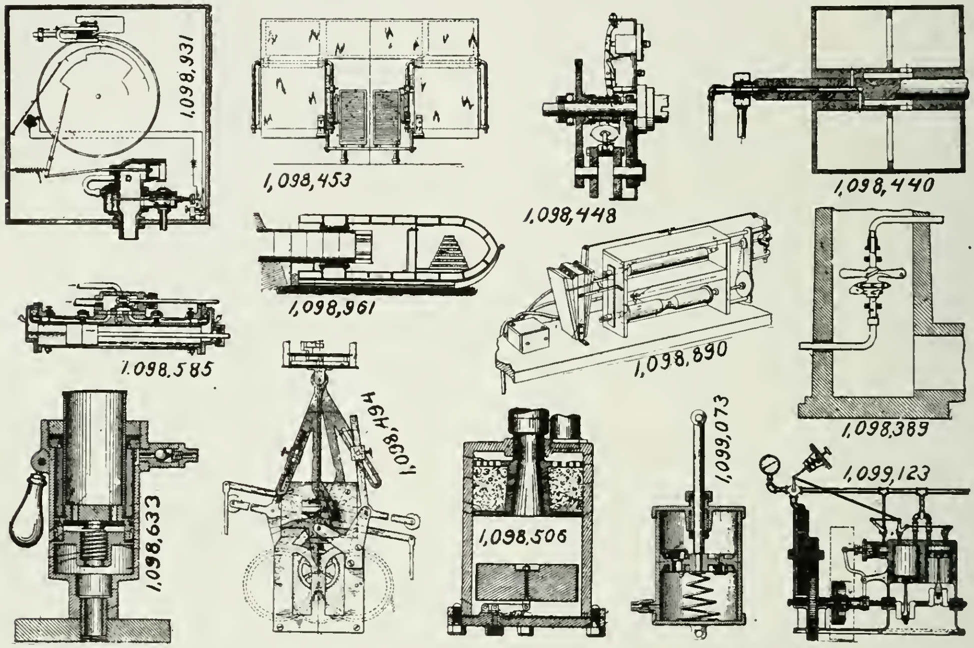
1,099,161. TRANSMISSION MEANS. William E. Brown, Milwaukee, Wis.

1,099,170. PROCESS FOR INCREASING THE PRODUCTION OF OIL-WELLS. Irwin L. Dunn, Marietta, Ohio.

1,099,242. LUBRICATOR FOR PNEUMATIC APPARATUS. Edwin A. Emery, Denver, Colo.

1,099,286. TRIPLE VALVE. Frank H. Dukesmith, Pittsburgh, Pa.

1,099,287. CONTROL-VALVE FOR TRIPLE VALVES. Frank H. Dukesmith, Pittsburgh, Pa.



Pneumatic Patents June 2.

1,098,890-1-2. PNEUMATIC SHEET-CONTROLLING MECHANISM. Joseph W. Dickinson, Cranford, N. J.

1,098,931-2. PRESSURE - RECORDING INSTRUMENT. Nicholas W. Akimoff, Philadelphia, Pa.

1,098,961. TUNNEL - HEAD. Sylvenus D. Mosher, Storm King, N. Y.

1,099,073. SHOCK - ABSORBER FOR VEHICLES. James Moir, Burlington, Iowa.

1,099,123. ENGINE - STARTER. Edgar F. Fruehbeck, Marfa, Tex.

1. A device of the character described including a fluid pressure turbine and means for applying fluid under compression thereto, whereby said turbine is rotated, a shaft, means operatively connecting said turbine with said shaft, an engine fly wheel, a rotatable member in operative connection with said fly wheel and loosely mounted on said shaft, a clutch member slidably mounted upon the shaft, but fixed against relative rotation thereon, a mechanism operatively connected with the clutch member and normally holding said member in engagement with the rotatable member carried by said shaft and means for applying fluid pressure to said mechanism whereby said clutch member is disengaged from said rotatable member.

1,099,344. INSTRUMENT FOR WRITING, MARKING, OR DECORATING WITH PLASTIC MATERIALS. Edward B. Desenberg, Kalamazoo, and Edward S. Pilsworth, Battle Creek, Mich.

1,099,392. PNEUMATIC - TURBINE DRILL. Reinhold A. Norling, Aurora, Ill.

1,099,411. MEANS FOR INCREASING THE EFFICIENCY OF FUEL FOR MOTIVE POWER. Willet C. Wells and Frank E. Wells, Columbus, Ohio.

1. An apparatus for converting the chemical energy of fuel into mechanical force by expanding compressed air by the heat and gases of combustion, supported by said compressed air comprising a furnace in which said combustion takes place, an air compressor arranged to supply to said furnace a variable volume of uniformly compressed air, a motor in direct communication with said furnace operated by the heat expanded compressed gases therefrom, and a governor adapted to regulate the flow of said gas from said furnace to said motor.

1,099,457. REGULATOR FOR FLUID-COMPRESSORS. Frederick V. D. Longacre, Yonkers, N. Y.

1,099,483. FLUID-OPERATED TOOL. Lewis C. Bayles, Easton, Pa.

1,099,557. ART OF PREPARING DISINTEGRATED MATERIALS FOR PACKING. William A. Lorenz and Joseph Merritt, Hartford, Conn.

1. The method of preparing food seeds for market which consists in disintegrating said seeds, withdrawing the free air from the seeds while they are being disintegrated, and feeding the disintegrated product with the free air withdrawn to a packing receptacle.

1,099,560. PORTABLE VACUUM-CLEANER. Louis D. Matchette, Milwaukee, Wis.

1,099,585. AUTOMATIC CAR AND AIR COUPLING. Harry F. Woernley, Pittsburgh, Pa.

1,099,670. PNEUMATIC - TOOL RETAINER. Edward J. Shoffner, Roanoke, Va.

1,099,680. PNEUMATIC-CLEANER CONTROLLER. Edgar F. Weirich, Milwaukee, Wis.

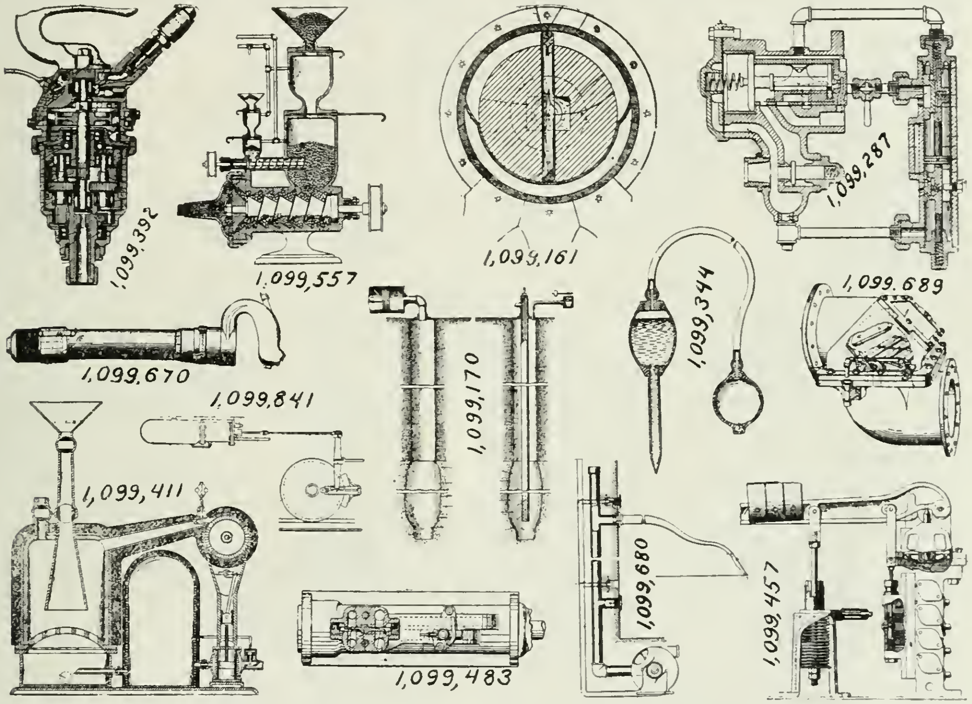
1,100,028. VACUUM DRYING APPARATUS. Albin Ravautte, Marseille, France.

1,100,056. AIR-PUMP FOR AUTOMOBILES. Charles N. Colstad, Atlantic, Mass.

1. The combination with an internal combustion engine, of a fan-supporting bracket sustained thereby, an engine-cooling fan supported by said bracket, engine-operated fan-driving mechanism, said bracket having a pump cylinder formed as an integral part thereof, a pump piston operating in said cylinder, and means to operate the piston from the fan-driving mechanism.

1,100,071. ROCK-DRILL. Louis W. Greve, Cleveland, Ohio.

1,100,109. AIR-COMPRESSOR. Glenn N. Wilkinson and Fred M. Hamilton, Battle Creek, Mich.



Pneumatic Patents June 9.

1,099,689. ATMOSPHERIC RELIEF-VALVE. Frank S. Broadhurst and Louis L. Pratt, Philadelphia, Pa.

1,099,841. AUTOMATIC AIR-BRAKE FOR RAILWAY-CARS. William G. Canion, El Paso, Tex.

JUNE 16.

1,099,957. SOLDERING-TOOL. Charles Willmott, Smethwick, England.

1,099,977. PUMP. John Fournia, Albany, N. Y.

1. The combination of a reciprocative pump, a motor for operating the pump, and means operated by the fluid pressure developed in the pump for increasing the power applied by the motor to the pump on the work stroke of the pump and decreasing the power on the suction stroke of the pump.

1,099,973. ACETYLENE-TORCH. George H. Dyer, Somerville and John W. Whitford, Boston, Mass.

1,099,994. PNEUMATIC ROCK-DRILL. Gaylord A. Orr, Cripple Creek, Colo.

1. In an air compressor comprising two concentric pistons and cylinders, the outer cylinder having an exhaust port controlled by the outer piston, the inner cylinder being open at one end to atmospheric pressure and having at the opposite end a port leading into the outer cylinder and controlled by the inner piston, the pistons of both cylinders operating in unison.

1,100,126. PROCESS OF AND APPARATUS FOR AERATING AND FEEDING LIQUID FUEL. Samuel J. Eva, Henry P. Gray, and James Robert Christy, Oakland, Cal.

1. In the art of preparing and feeding aerated liquid fuel, the process of continuously spraying by external pressure liquid fuel into an aerating chamber at the top, continuously supplying to said aerating chamber air under pressure greater than atmospheric, continuously drawing out from said chamber, near the bottom thereof, the aerated liquid fuel at a rate not greater than that at which it is supplied thereto, and automatically removing from the liquid fuel so aerated any excess thereof above a predetermined amount.

1,100,144. MEANS FOR HUMIDIFYING AND WASHING AIR. William C. H. Noble, Los Angeles, Cal.

1,100,230. RIVETING-TOOL. Ulysses G. Detwiler, Verona, Pa.

1,100,260. PROCESS OF OBTAINING LIQUID HYDROCARBONS. Emil Schill, New York, N. Y.

1. The process of separating the pentanes from a volatilized mixture of hydrocarbons which comprises subjecting such mixture to pressure in the presence of a finely divided heat absorbing agent, liquefying such of the compressed gases as normally volatilize at temperatures above approximately 25 degrees C., maintaining in the liquid thus produced the condition of its creation, distilling the pentanes from said liquid, liquefying same and storing same under seal.

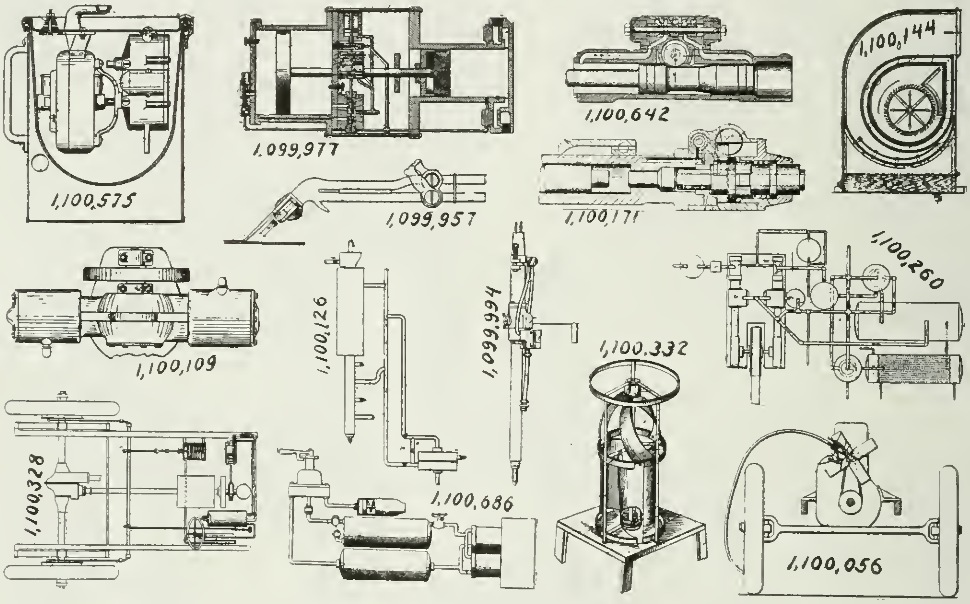
1,100,328. AIR-BRAKE PUMP. John Schmid, Jr., Kansas City, Mo.

1,100,688. FLUID-PRESSURE-PURIFYING SYSTEM. George M. Spencer, St. Louis, Mo.

JUNE 23.

1,100,705. APPARATUS FOR DISCHARGING ASHES AND OTHER MATERIALS FROM SHIPS. Willoughby Lake Baylay, Blackheath, England.

3. In apparatus for discharging refuse from ships, the combination with a water pipe having a sub-aqueous discharge end and means to maintain a constant stream through said pipe under all conditions of operation; of a receptacle for refuse, a duct discharging into said pipe, a valvular device for receiving refuse from said receptacle and delivering the same to said duct while preventing at all times communication between the duct and receptacle, and means to supply compressed air to said valvular device when discharging into said duct, for the purpose specified.



Pneumatic Patents June 16.

1,100,332. WINDMILL. James B. Smith, San Saba, Tex.

1,100,568. PNEUMATIC ACTION. Henry H. Holtkamp, Lakewood, Ohio.

1,100,575. VACUUM-CLEANER. James B. Kirby, Cleveland, Ohio.

1,100,605. FLUID-MOTOR. Arthur George Lloyd Neighbour, Beaumaris, Victoria, Australia.

1,100,611. PNEUMATIC PLAYER. Gustaf W. Paulson, Belmont, and Rudolf Paulson, Boston, Mass.

1,100,642. VALVE. Frank E. Willey, Claremont, N. H.

1,100,675. PROCESS OF ELIMINATING IRON FROM LIQUIDS. Heinrich Hackl and Hugo Bunzel, Heufeld, Germany.

1. A process of recovering values from a solution containing ferrous salts, zinc salts, and sodium sulfate, a part at least of said zinc and iron salts being in the form of chlorids, which comprises adding thereto a relatively small amount of a copper compound, blowing air through said liquor until the oxidation of the iron and copper compounds is substantially complete, a compound capable of neutralizing acid being present in the liquor during the oxidation of the iron.

1,100,677. AIR CLEANSING AND HUMIDIFYING MACHINE. Harvey E. Leach, Miles City, Mont.

1,100,717. TREATING OIL. Jesse A. Dubbs, Pittsburgh, Pa.

1. As an improvement in the art of distilling hydrocarbons, the method herein described which consists in heating the material to a point at which the hydrocarbons would be broken up if mingled with air, forcing air through the same and maintaining the heat by the chemical reaction produced.

1,100,825. FLUID-OPERATED TOOL. Louis W. Greve, Cleveland, Ohio.

1,100,867. APPARATUS FOR TRANSMITTING AND INDICATING FLUCTUATING PRESSURES OF WATER, GAS, AND STEAM. MacDougald Dexter, Columbus, Ga.

1,100,940. AIR-CLEANING MACHINE. Howard S. F. Barner, Allentown, Pa.

1,100,959. FODDER-CUTTER DISCHARGE-PIPE. Joseph Dick, Canton, Ohio.

1,100,992. COMBINATION SUCTION ELEVATOR AND LOADER. Robert A. Sallee, Middletown, Cal.

1,101,102. INTERMEDIATE STOP DEVICE FOR PNEUMATIC ELEVATORS. George F. Steedman, St. Louis, Mo.

1,101,120. RAILWAY SIGNALING APPARATUS. Clyde J. Coleman, New York, N. Y.

1,101,143. VACUUM-PUMP. Harry Neville, New York, N. Y.

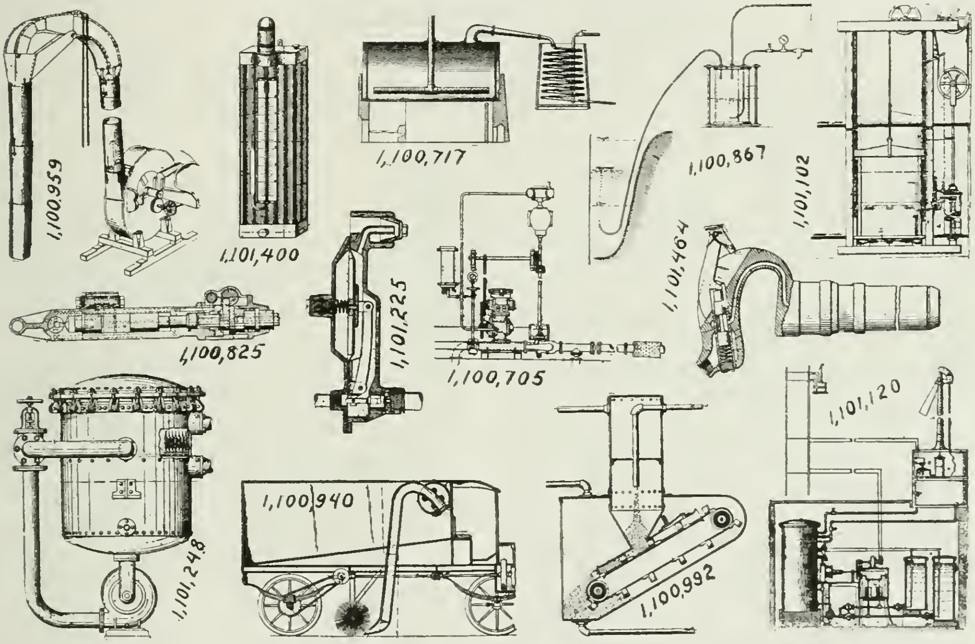
1,101,173. PIANO-PLAYING PNEUMATIC ACTION. Robert A Gally, Cincinnati, Ohio.

1,101,225. GAS-REGULATING VALVE. Harry E. Wolf, Webster Groves, Mo.

1,101,248. APPARATUS FOR TREATING TEXTILE FIBERS WITH LIQUIDS AND GASES. John Brandwood, Thomas Brandwood, and Edward Brandwood, Bury, England.

1. Apparatus for first treating cops with liquid and then treating them with air without removing them, such apparatus comprising a keir, a transverse partition therein for bearing the cops and dividing the keir into upper and lower compartments of which the lower is the larger, a liquid circulating pump and its pipes, air and liquid inlets to the upper compartment, and air and liquid outlets in the lower compartment, substantially as set forth.

1,101,400. APPARATUS FOR ASCERTAINING THE DEGREE OF PURITY OF AIR. Juan Calafat y Leon, Madrid, Spain.



Pneumatic Patents June 23.

1,101,464. SAFETY DEVICE FOR PNEUMATIC HAMMERS. Charles F. McDonald, Philadelphia, Pa.

JUNE 30.

1,101,558. APPARATUS FOR VACUUM-CLEANING. Hiram Stevens Maxim, West Norwood, England.

1,101,572. PROCESS OF MAKING CANDY. Peter H. Schlueter, Chicago, Ill.

1. The process of making candy which consists in cooking a solution of cane sugar and a reversion preventing agent at atmospheric pressure to a temperature higher than the cracking point but insufficient to complete the cooking operation and in then subjecting the batch to a vacuum until cooked without raising the temperature above that attained at atmospheric pressure.

1,101,698. AIR - GUN. Arthur Adelbert Karcher, St. Joseph, Mich.

1,101,708. MEANS FOR INFLATING PNEUMATIC TIRES OF MOTOR-CARS AND OTHER VEHICLES. Niels A. Nielsen, Marton, New Zealand.

1,101,784. SYSTEM FOR CONTROLLING THE HUMIDITY AND TEMPERATURE OF AIR. Willis H. Carrier, Buffalo, N. Y.

1,101,787. APPARATUS FOR REGULATING THE AIR-SUPPLY FOR GAS-PRODUCERS. Henry L. Doherty, New York, N. Y.

1,101,789-90. METHOD OF BURNING LIQUID FUELS. Henry L. Doherty, New York, N. Y.

1. The process of burning liquid hydrocarbons to effect decomposition of materials, which comprises, atomizing the said liquid hydrocarbons by a jet of air under pressure, conducting the mixture of atomized hydrocarbons and air into a refractory-walled chamber, subjecting the hydrocarbons of said mixture to partial combustion in said chamber to convert said hydrocarbons into combustible gases and to heat the gases produced to a comparatively high temperature, introducing into the hot combustible gases produced by said partial combustion a further portion of air diluted with gases derived from the decomposition of said materials, whereby the gases produced by said partial combustion are subjected to slow combustion, and conducting the slowly burning gaseous mixture into contact with said materials.

1,101,901-2. HUMIDIFYING APPARATUS. William G. R. Braemer, Camden, N. J.

1. The herein described method of obtaining humidified air having substantially constant humidity, which consists in treating the fresh air to an aqueous vapor to impart to it approximately the humidity required, simultaneously collecting a plurality of samples from different portions of the flowing body of humidified air taken at substantially the same transverse section of the conduit through which the air is flowing, mixing the several samples to provide a common average sample of the humidified air, and varying the temperature of the fresh air before it is subjected to the aqueous vapor under the control of the condition of the average sample of humidified air, whereby the humidity of the treated air may be maintained substantially constant.

1,101,919. PNEUMATIC AND SELF-PLAYING MUSICAL APPARATUS. Robert A. Gally, Brooklyn, N. Y.

1,101,929. COMPRESSOR FOR GASES. Robin A. Hayes, Edgbaston, England.

1,101,950. OUTSIDE TUBE-CLEANER. James Ogg, Pahala, Hawaii.

1. A tube cleaner, consisting of a cylindrical body to slip over a tube, said body carrying an internal sleeve member, an annular rotor mountable on the sleeve member, an annular nozzle ring on the sleeve, a fluid pressure chamber delivering fluid through the nozzle ring to the rotor, scrapers carried by the rotor, a manifold disk, and pipes connecting the chamber and the manifold disk with said fluid pressure chamber for delivering fluid pressure thereto to operate the rotor, substantially as described.

1,101,979. PNEUMATIC-VALVE MECHANISM. William A. Watson, Malden, Mass.

1,102,012. ROCK-DRILL. John Thomas Curnow, Palatka, Mich.

1. A rock drill, comprising an engine having a power cylinder, a reciprocating piston mounted therein, and a valve-actuating mechanism; a chamber disposed in line with said cylinder; an open-ended hollow drill rod operatively connected with said piston to extend through said cylinder and into said chamber; means for connecting said chamber and a water supply, said means embodying a nozzle; and means, embodying a relatively small delivery nozzle operatively mounted within said first-mentioned nozzle, to rarefy the air in said first-mentioned nozzle, to draw a supply of water into said nozzle.

1,102,017. REPAIR DEVICE FOR PNEUMATIC TIRES, &c. Timothy C. Dobbins, Los Angeles, Cal.

1,102,020. DOUBLE-HEADING AIR-BRAKE SYSTEM. Frank H. Dukesmith, Meadville, Pa.

1,102,033-4. ATOMIZER. Edward Joseph Franklin, Salt Lake City, Utah.

1,102,071. CONDENSING APPARATUS. Charles Algernon Parsons, Newcastle-upon-Tyne, and Stanley Smith Cook, Wallsend, England.

1. An apparatus for obtaining a high degree of vacuum comprising in combination a motor, a condenser receiving the fluid discharged from said motor, exhausting means, a pipe connection between the condenser and the exhausting means, a drainage pipe connection from the motor to the exhausting means, augmentor means having a connection to the connection between the condenser and exhausting means, said connection being made at the level to which condensed fluid is permitted to rise within the motor, a connection conveying fluid from the augmentor means to the exhausting means and means by which any uncondensed fluid which has already passed from the augmentor means to the exhausting means is prevented from circulating through the other pipe connections back to the augmentor means.

1,102,099-100. AIR-BRAKE SYSTEM. Jacob Rush Snyder, Pittsburgh, Pa.

1,102,130. VACUUM-CLEANER. George S. Bennett, San Francisco, Cal.

1,102,152. PROCESS OF PUMPING OIL-WELLS. Philip Jones, Santa Maria, Cal.

1. The herein described method of pumping oil wells, comprising the formation of a column of mixed oil and a gas incapable of supporting combustion, the separation of the oil and gas, and the separation of the gas and the vapors carried thereby by means including compression.

1,102,142. PNEUMATIC CLEANING - TOOL. Robert L. Cooley, Milwaukee, Wis.

1,102,165. PNEUMATIC - DESPATCH - TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.

1,102,168. FLUID-GAGE. Oliver C. Ritz-Woller, Jacksonville, Fla.

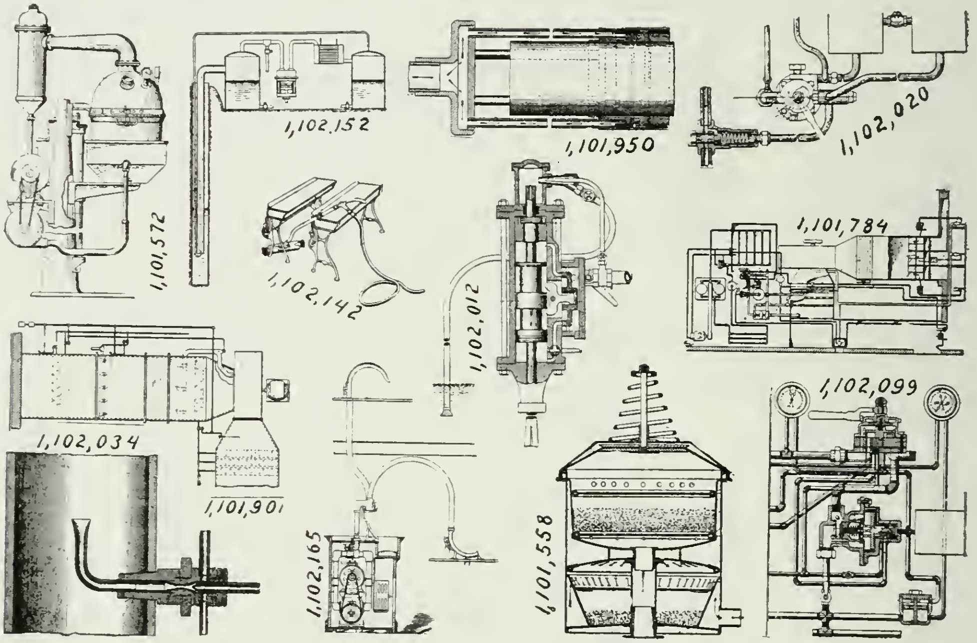
1,102,185. PNEUMATIC - DESPATCH - TUBE APPARATUS. James T. Cowley, Boston, Mass.

1,102,204. AIR-GUN. Earl V. Shue, Milwaukee, Wis.

1,102,216. PIANO-PLAYING AIR SYSTEM. Robert A. Gally, Cincinnati, Ohio.

1,102,222. FLUID-PRESSURE APPARATUS. William G. Abbott, Jr., Milford, N. H.

1,102,225. PNEUMATIC - DESPATCH - TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.



Pneumatic Patents June 30.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol XIX SEPTEMBER, 1914 No. 9

AIR RECEIVER FIRES AND EXPLOSIONS

BY FRANK RICHARDS.

The present article was prepared in response to the following letters of inquiry originally addressed to the *Colliery Engineer*:

"How does oily waste accumulate in an air receiver, and what steps should be taken to prevent this accumulation? If an air receiver with an accumulation of oily waste is liable to take fire if allowed to get hot, what steps should be taken to prevent its getting hot?"

"How can cylinder oil be prevented from accumulating on the top of water in an air receiver? I read that 'When the water is drawn off the oil will be deposited on the inner surfaces of the receiver and will be in suitable condition to evaporate and cause an explosion of great violence.' We blow out our air receiver every time the water gage shows a certain accumulation; should we do it oftener?'

It is not possible with few words to dispose of all the matters suggested by the above letters for discussion. One of the earliest and most persistent of air compression troubles is that resulting from the use of lubricating oil in the cylinders. This oil cannot remain where it is functionally employed, but is carried away a little at a time by the compressed air, and it naturally accumulates in the receiver and the pipes.

Drawing off, or blowing off, the water in the receiver—and often there is very little water accumulating there—does not generally get rid of the oil, which clings to, and cakes on to, the bottom and sides of the receiver and all along the pipes. This oil has been exposed to high temperature in the act of compression, and generally all of it which could be volatilized at the highest temperature reached has been carried along by the air, and what remains is semi-solid, black and sticky.

The only way to get rid of it when once deposited must be by mechanical means such as actual scraping of the surfaces, so that air receivers would seem to require manholes rather more than steam boilers do, but it is not generally the fashion to provide them. By the way, if any one is to enter an air receiver for the purpose of scraping and cleaning it, the respirable condition of the air within should first be assured.

In the course of time, if oil is used "liberally" in the cylinders, and if nothing else is done about it, the accumulation of this gummy and highly combustible material may become quite thick, and then it becomes only a question of time as to when it will take fire. Such fires have been so frequent, the cases of air receivers becoming red hot, or nearly so, have been so numerous that no one has thought it worth while to keep a record of them.

It is encouraging to note that while the number of compressed air plants has increased beyond computation the cases of air receiver fires and explosions are apparently much less numerous than, say, a score of years ago, which shows that our practice has vastly improved, the pertinent details of which practice may appear as we go along.

As to what can cause the ignition of the oily deposit in the air receiver may seem quite puzzling at first, but there are ways to account for it. It may be thought, for instance, that the actual temperature reached in the single act of compression is not sufficient to cause it, but it certainly comes quite near it in some cases. Single-stage compressors in the olden time, say in the time of the building of the "new" Croton aqueduct, a little over a quarter of a century ago, were often worked up to 100 lb. gage, and the receiver fires were frequent.

Published tables assume, for convenience, the temperature of the intake air to be 60 degrees F., and the temperature of the air when compressed to 100 lb. is 485 degrees. As a matter of fact the air is heated more or less in entering the cylinder, so that when compression begins, even with intake air nominally at 60 degrees, the actual temperature of the air at the beginning of the compression is probably not less than 100 degrees, and then the terminal temperature after the compression would be 550 degrees.

In a case of which I had full personal knowledge a portable oil-engine-driven air compressor was working in the hot sun in the last week of June, entirely without shade or protection, and the receiver took fire internally and exploded. The interior of the receiver after the explosion (which was a simple pressure explosion, due to the fact that the receiver when so heated was not strong enough to stand the regular working pressure) showed the oil entirely burnt off the head, with every indication that it had been red hot.

In this case it is safe to assume that the air, hot to begin with and heated more in passing into the cylinder, was above 120 degrees at the beginning of the compression stroke, and that the temperature after the compression was at least 650 degrees. Certain oils will take fire spontaneously, and without the assistance of any igniting flame, at such temperatures as this, as is seen in the time honored process of tempering steel springs by "blazing off" in oil.

I have been unable to find any authoritative tabulated statement of the temperatures of spontaneous ignition for the different oil, although it would be a comparatively simple matter to experimentally obtain the necessary data. We have the flash points and the burning points, but not the point here called for.

If spontaneous ignitions of oil can occur and do occur in the open atmosphere at temperatures which are reached or closely approximated in adiabatic single stage compression, it is safe to expect that such ignitions should occur at lower temperatures when the compression concentrates six or eight times the quantity of air, and six or eight times the quantity of its oxygen constituent, at every point of contact with the oily deposit.

It is proper here also to suggest the possibilities of spontaneous ignition at much lower temperatures than here spoken of where oil is intimately mixed with other materials. I have seen the sweepings of a machine shop floor collected in heaps to be picked up and carried away, and in half a day if neglected they would begin to smoke, while if left undisturbed for a whole working day and then stirred up they would show actual fire within, sometimes bursting into flame. Other illustrations in this line will readily suggest themselves.

We are not always quite as careful as we should be—often quite the reverse—about screening and guarding the air intake, and dust is often carried by the air in such quantities as to form a considerable aggregate. This dust collects and mingles more or less with oil which accumulates in the receiver and, not being disturbed when once deposited, the combination, if of the right materials, may easily generate heat sufficient to cause ignition independently of the heat due to the compression. To ignite the oil surfaces it is only necessary to have a fiery glow, and then a flame, at a single point to have the fire immediately spread rapidly and burn fiercely if the compressor is running. Such fire must soon smother itself if the compressor ceases to supply and circulate fresh air.

If the conditions here suggested are permitted to exist, as leading to these ignitions of the oily deposit, the receiver should be strong enough to stand the working pressure even when thus heated by sudden internal combustion, and it may be said that generally air receivers are so strong that pressure explosions from this source are quite infrequent as compared with the numbers of internal fires that occur. When a receiver fire is discovered, by the sudden heating of the receiver or otherwise, the compressor should be stopped at once to check the supply of fresh air.

When we are informed of the conditions causing or preceding these air receiver fires it would seem to be a simple matter to avoid them. Stage compression should be insisted upon, with efficient intercooling and aftercooling. This would make the high temperatures impossible and would at the same time reduce the lubricant requirements. Some astonishing records have been made of minimum consumption of lubricating oil at Panama and elsewhere, and air receiver fires have been unknown where these conditions have prevailed.

This is not all of the story about air receiver explosion. There are two very different types of explosions and one definition of the word does not satisfactorily cover them both. There is the explosion which takes place when the only pressure present is the regular gage pressure, perhaps slightly increased for the time, but due entirely to the mechanical compression of the air, and when the receiver or the piping is at the moment not strong enough to withstand this pressure, and then there is a much more destructive explosion caused by a sudden and enormous increase of pressure caused by the ignition of an explosive mixture of some volatile constituents of the oil with the air. The pressures resulting from explosions of this character are comparable with those resulting from the explosions of gunpowder, and the results are correspondingly severe. It is especially for the avoidance of explosions of this type that it is recommended that the oil used shall have as high a flashpoint as possible, which means that the more volatile constituents of the oil shall have been already eliminated.

It is a fortunate circumstance that to form a mixture which shall be destructively explosive the proportions of air and of oil vapor must be within certain quite narrow limits. Thus in gasolene engine practice it has been found that the explosive range of mixture is between 2 to 5 per cent. of gasolene vapor and 98 to 95 per cent. of air. Nevertheless such explosive mixtures do form in compressed air receivers, or more frequently in the pipes leading from them, and such mixtures are sometimes ignited with explosive effect. The ignition may come from the receiver taking fire as previously explained and then the flames being carried along with the air until a point is reached where the explosion proportions of mixture exist.

It seems to be quite certain that if due precautions are taken to prevent accumulations of oily residue and dirt, and if high temperatures are avoided in compression, as economy itself would dictate, neither fires nor explosions will occur.

After the above was written and before its publication the following note from Mr. John J. Oelrich, Amadoville, Ariz., appeared in *Power*:

"I fed a lot of oil into a two-stage, tandem air compressor to be sure I would get enough into the cylinder, but I used too much, and it exploded in the high-pressure air cylinder. No damage was done to the air compressor, but the high-pressure air line ruptured in five different places. Small pieces of copper pipe were found all over the building and some went through the roof. Fortunately, no one was injured."

Although this note is so short it seems to tell a complete story of incidents occurring precisely as I have outlined them above. The excess of oil and the high working temperature being provided, the ignition in or close to the cylinder and then the explosion in the pipes followed according to schedule. It is evident that, while there was in the cylinder an ignition of the oil, there was no explosion there or the cylinder would have blown to pieces just as the pipes did, the one being presumably no stronger than the other, in proportion to their sizes and responsibilities.

COST OF SUBAQUEOUS SHIELD TUNNEL DRIVING

The following is abstracted from a paper by P. A. N. Seurot, before the Canadian Society of Civil Engineers.

Leaving aside all special work and considering only the standard tunnel driven under compressed air, including excavation, cast iron lining, bolts, grouting, rust or cement jointing, concreting, the writer has endeavored, in so far as it is possible, to figure the cost of such a structure, reduced to unit cost per cubic yard of excavation, or, more exactly, per cubic yard of tunnel space. This unit cost represents, as nearly as can be ascertained, the cost to the contractor or constructing company, exclusive of cost of financing, of amortization, of interest on capital, and exclusive of profit. Neither does it include permanent way or equipment. This unit cost oscillates between $27.00 and $32.00 per cubic yard of tunnel. Among others, two examples were chosen, one being the Pennsylvania Hudson tunnels, 23 ft. in diameter, in which this unit cost was $31.00, and the other, the Paris Concorde tunnel, 25 ft. 6½ ins. diameter, the unit cost of which was $29.12. It may be noted, however, that there was very heavy concreting in the Pennsylvania tubes and very little in the Paris tunnel. In the Pennsylvania tubes there were also two special machined steel segments, spaced every 15 ft., which evidently increased the cost to a certain extent. The cost of labor was greater in New York than in Paris; on the other hand, the price of cast iron was double in France than in the United States. Taking the unit cost of the Paris tube at $29.12 per cubic yard, the various items making up that price are as follows:

Superintendence and labor	$10.00	34.34%
Plant charges	3.65	12.53%
Lining	11.00	37.77%
Bolts	0.78	2.68%
Blasting	0.4	0.13%
Grouting	0.83	2.89%
Jointing	0.11	0.37%
Wooden furring strips	0.05	0.17%
Concreting	0.70	2.40%
Cement facing	0.16	0.54%
Power	1.80	6.18%
Total	$29.12	100.00%

A POPULAR DRILL IN THE COPPER COUNTRY

Stimulated by the special requirements of the Calumet & Hecla Company, after much experimenting during the past three years, strength and power being the two most important factors in the work, there has developed a drill that is practically adapted to the Calumet conglomerate. The piston for the "Butterfly" Ingersoll-Rand drill has been increased from 2¾ ins. to 3⅛ ins., so as to give the required power, and the weight and strength has been correspondingly increased. This drill is known as the "D 113." It is best operated by 2 men. The diameter of ⅞ in., instead of 1¼ ins. is being tried here for the steel, or drills proper, of the Leyner-Ingersoll machines; the hexagon steel being provided with a collar and a special chuck, while at the Copper Range Con. it is equipped with lugs. The "Baby" Leyner, "26," is also being tested out here. There are now about 100 of these drills in use at the Quincy, together with over 100 Jackhamers, which at that mine are incased in shells and attached to posts, and are used for almost any drill work. They are coming into favor at the Mass and Victoria. The Leyner-Ingersoll "18," however, has become the standard for the Amygdaloids in almost all of the mines in the Copper country.—*Min. and Eng. World.*

While a man in Hanover, N. H., was stirring a pot of paint over a wood fire recently his celluloid collar caught fire and he was burned to death.

DRIVING WESTON COLLIERY TUNNEL

BY S. W. SYMONS.

Although presenting a problem not unlike that of any number of other such tunnels, the "entry tunnel" recently driven for the Locust Mountain Coal Company, Shenandoah, Pa. and the methods by which the work was prosecuted, are of interest to coal operators and tunnel contractors by reason of the remarkably uniform and rapid progress made.

The tunnel is 12 feet wide by 7 feet high with a ditch 4 ft. by 2 ft. at the side. It was driven through a hard conglomerate, with the exception of 450 feet through red shale carrying a small quantity of water. The total driven length was 3,689 feet.

Two Imperial air compressors, belted to General Electric motors supplied the air for the drills, these compressing 560 cubic feet of free air per minute to 110 pounds, gage, at the receiver, giving 105 pounds at the drills; only one machine was in use at a time. An attempt was made to lower the air pressure to reduce the strain on the drills, but this was quickly abandoned owing to the complaints from the drill runners, who noticed the change at once and claimed that, owing to the hardness of the rock, the drilling speed was reduced.

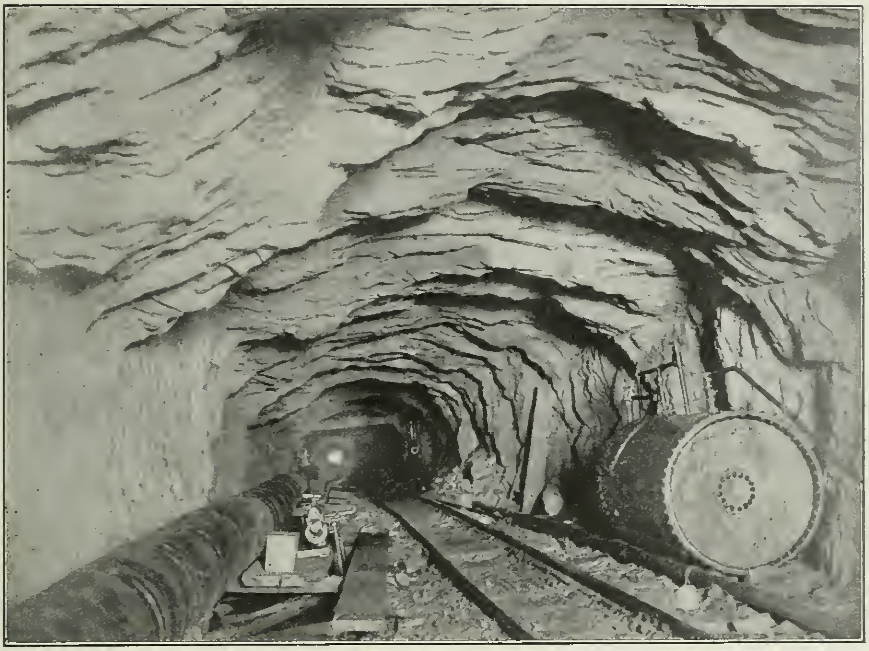
Two Leyner-Ingersoll drills were used on a 7-foot horizontal bar with a third kept in reserve. One "Butterfly stoper" and one Jackhamer were used for trimming and ditch work.

Water was supplied to the drills by a direct acting Cameron pump operated by air and seen in Fig. 1. This pumped the water from the drainage ditch into the tank shown on the right and air was turned on to keep it at an even pressure at the drills.

All steel was sharpened by an air-driven Leyner sharpener. The blacksmith shop equipment included a coke forge.

Ventilation was furnished by a pressure fan driven by a General Electric motor. This was placed at the entrance to the tunnel and the air forced through a 20-inch galvanized iron pipe. Air for the drills was carried through a 3-inch pipe ending in a manifold.

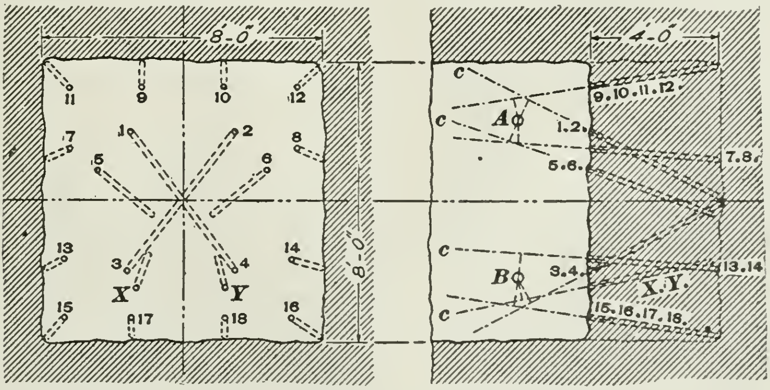
For handling the muck, six 1-yard side-dump cars were used, drawn by an electric storage-battery locomotive. Track of 24-inch gage was used and a false track kept well up to the face.



WESTON COLLIERY TUNNEL.

Three shifts per day were worked. Each crew averaged 6 hours at the face, from the time the crew entered until the round was completely drilled. Each shift comprised 1 shift boss, 4 machine men, 6 muckers, 1 motor man, 1 brakeman, 1 ditch and floor walker, and 1 man to dump the muck.

The three-shift method of driving was found feasible by employing high speed drills of the self rotating hammer type, and by the adoption of a comparatively shallow cut; approximating 5½ feet per shot, although the drill holes averaged 6 feet. This is in line with the most modern practice in tunnel driving, it being found that a slight decrease in depth of cut with a larger number of comparatively small holes, carefully placed, permits employing more shifts in a given time and a considerable increase in speed of driving. Though no attempt was made at record breaking, a remarkably uniform yet fast speed was maintained over the whole period of driving. The



THE LEYNER CUT.

average rate accomplished was 15.66 feet per day.

Considering the extreme hardness of the rock, this compares very favorably with such tunnels as the Laramie Poudre, the Montreal, and the Loetschberg. The best month's progress was during October, 1913, when 513 feet were driven in 28 working days.

The drilling round varied considerably, being changed according to the nature of the ground. In general, the system followed was that known as the "Leyner cut," shown in Fig 2, in which 18 to 24 holes were drilled. The average time for drilling the round was 5 hours. Hercules blasting gelatine of which 77,975 pounds of 60 per cent. and 3,150 pounds of 50 per cent. with a small quantity of 40 per cent. and 100 per cent. was used. The shots were fired by fuse, cut to such lengths that the holes would fire in the order desired, the cut holes being the first to break. A total of 164,250 feet of Crescent fuse. and 20,02 No. 8 caps was used.

In general, the muckers were able to enter the tunnel 15 minutes after shooting; this was made possible by the efficient system of ventilation assisted by turning on full air pressure from the compressors immediately after shooting. In from 15 to 30 minutes the muck pile was sufficiently reduced to allow operating the drills from the top set-up. Here the advantages of the tunnel bar over the usual column is clearly shown. All holes but the three lifters were drilled from the upper set-up of the bar and as a rule the heading was completely mucked out by the time the drilling crew were ready to put in the lifters. The bar was then changed to the lower set-up and the three lift holes drilled, this operation taking between 15 and 30 minutes. The right-hand lift hole was drilled deep and low to form the ditch. The commendatory feature about the system was the prosecution of the drilling and mucking operations with the minimum loss of time for both drill runners and muckers.

The drills used embodied in their design a water feed attachment, which entirely eliminated the dust, the heading being remarkably clear except for a slight fog from the drill exhaust.

The tunnel was finished with ditch taken up and road to line and grade as the work progressed.

The use of a tunnel through the side of the mountain places all the coal in the vein, which is known as the Little Buck Mountain, above water level and allows economical transportation to the breaker as well as efficient drainage. The Little Buck Mountain bed is to be mined from the tunnel and the overlying veins by open cut and stripping methods. In all, the Locust Mountain Coal Co. expects to produce 1,000 to 2,000 tons daily.

The writer is personally indebted to Mr. Hugh Dolan, of Dolan Bros., of Pottsville, Pa., for the data herein contained and for assistance in procuring photographs.—*Colliery Engineer.*

INDUSTRIAL USES OF SUGAR

Sugar as such is often denatured, that is, some ingredient is added to make it unfit for food. The French government admits such sugar free of duty. Sugar is used as an ingredient in compounds that are manufactured in removing boiler scale. The shoeblacking industry consumes large quantities of sugar and molasses, and though in America there is a striking departure from the use of these old blackings by using wax blackings, yet the latter having too many solvents are not considered so good as the old-fashioned blacking still much in vogue on the European continent. Over thirty explosives have from 6 to 40 per cent. of sugar. Germany exempts these from duty when paraffin or similar oils are used. The dyeing industry commands large quantities especially in indigo and chrome work; sugar is also used in fillers for solid aniline colors, and in some of these as high as 90 per cent. is found. Tanneries also use sugar in filling the leather and in removing the hairs. The solvent action of sugar on lime has brought forth the suggestion of using it for removing an excess of lime from phosphates, zinc or magnesium oxides. Tannin extracts are also "filled" with sugar. Ordinary copying ink has one part of sugar and three parts of writing ink. Printers' rollers and hectograph pads are made in part of sugar. Silvering of glass mirrors is an important industry in Europe, and sugar, after inversion, is reduced to an ammonical solution of silver nitrate, which spreads itself over the surface of the glass. The ancients in the Far East used sugar in mortar to strengthen it. In recent times the Museum of Natural History in Berlin was built with mortar consisting of one part of lime, one part of sand and two parts of sugar. Plaster moulds are also made in part of sugar.

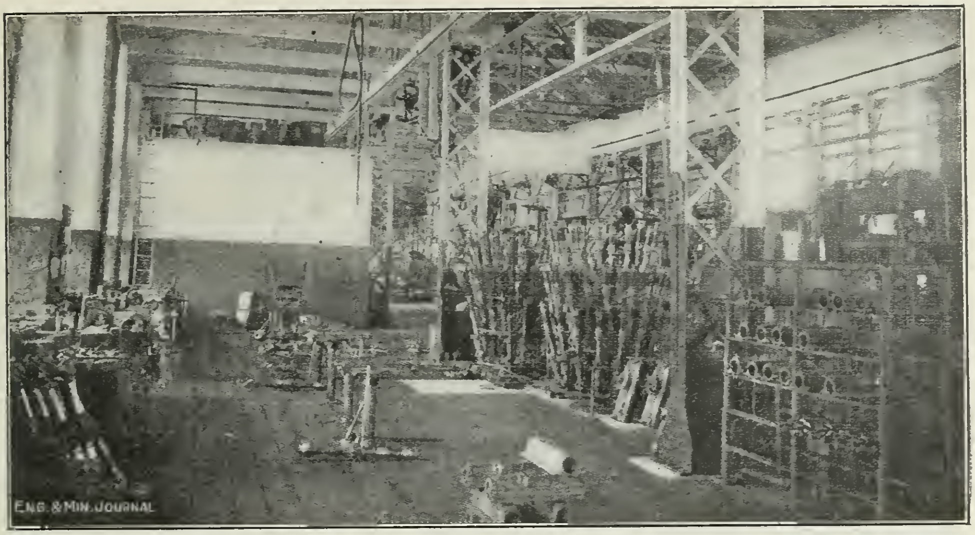


FIG. 1. CALUMET & HECLA DRILL SHOP.

MINE MACHINE SHOP EQUIPMENT*

BY F. A. STANLEY.

The mine machine shop, owing to its isolated location and the character of the operations, requires, as a rule, an equipment with greater range of capacity than that of the general repair plant situated in machine-shop districts. The mine shop is constantly called upon to make and repair parts, varying from small work up to heavy bed plates, big cylinders, pulleys and sheave wheels 12 to 15 ft. or more in diameter. Not infrequently the mine machine shop, started primarily as a small department for the purpose of overhauling and repairing engines, pumps, rock drills, and the like, develops into an important establishment not only capable of attending to all the repairs of the mechanical equipment of the mine, but also adapted to building much of the new machinery required. The mine shop in certain places also develops into a semi-commercial institution in that it is often called upon for all sorts of repairs required by other industries in the community.

Certain of the larger mining companies in this country maintain machine shops employing hundreds of mechanics and forming a part of extensive metal and woodworking plants, including iron and brass foundries, forge, machine and sheet-metal shops, pattern and carpenter shops, and so on.

THE CALUMET & HECLA SHOPS.

One of the largest and best equipped of these mine machine shops is that of the Calumet & Hecla Mining Co., at Calumet, Mich. This shop not only repairs all kinds of mining equipment, but also builds rock drills and other apparatus for the company's use.

The drill parts in particular are put through in large numbers and like various other parts are machined economically by the use of jigs and fixtures, so that in addition to a comprehensive equipment of standard machine tools, there are many special tools and appliances in the shop.

The shop building is of brick and frame construction, with the main bay served by a powerful traveling crane, the tools at either side of the bay being served by suitable jib cranes and hoists. The heavy lathes, boring mills, planers, radial drills and other large tools are arranged along the sides of the main bay, leaving the central portion of the floor clear for the free handling of material.

Rock-drill and other work of lighter nature is attended to in other departments, one of which is illustrated by Fig. 1, which shows some of the special apparatus developed for use in handling rock drills, either in connection with the making of new drill parts or in repairing old. The racks at the right form convenient storage space for drill cylinders and pistons ready for assembling, and the floor stands in front of the bench enable the

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*Condensed from Eng. and Min. Journal.

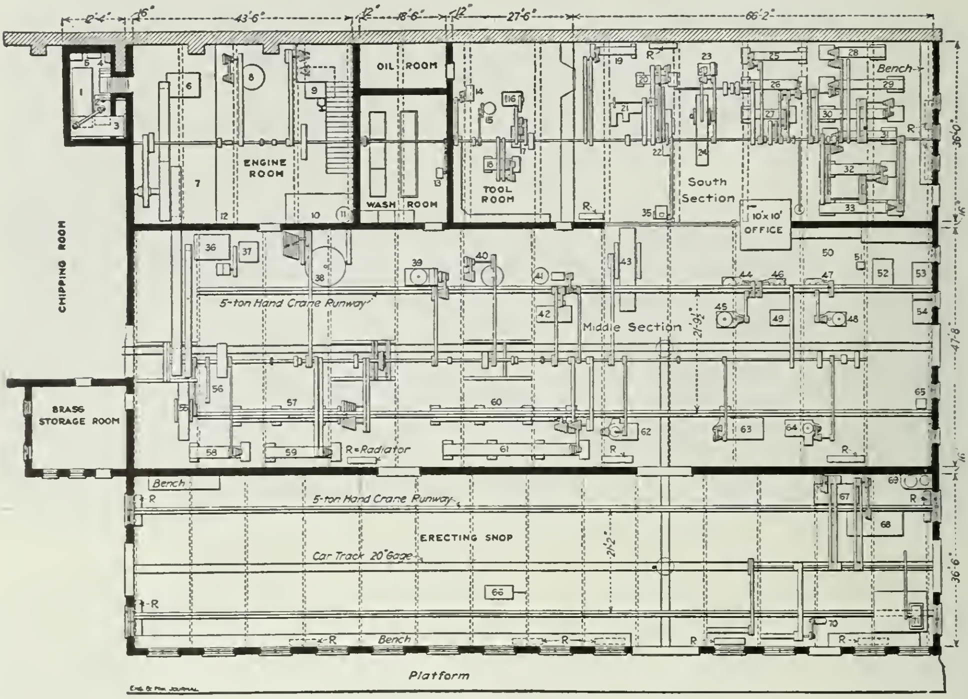


FIG. 2. LAYOUT OF ANACONDA SHOP.

LIST OF TOOLS IN ANACONDA SHOP.

No.	Machine
1	4x12-ft. receiving tank
2	3x7-ft. grease extractor
3	3x12-ft. feed-water heater
4	No. 0 pump feed
5	$5\frac{1}{4}$x$3\frac{1}{2}$x5-in. duplex feed pump
6	50-kw. 500-volt dynamo
7	18x36-in. engine
8	5-ft. pulley boring mill
9	5-ft. pulley lathe.
10	12x14-in. air compressor
11	40x96-in. air receiver
12	60-ton portable hydraulic press
13	magnetic separator
14	12-in. double-spindle drilling machine
15	tool grinder
16	10-in. drill grinder
17	14-in. box column shaper.
18	15x36-in. engine lathe
19	15x54-in. engine lathe
20	20x36x$2\frac{11}{16}$-in. turret lathe
21	15-in. shaper.
22	20x20x72-in. planer
23	No. 1 plain miller
24	30x30-in. by 10-ft. planer
25	24 in. by 8 ft. engine lathe
26	20 in. by 9-ft. engine lathe
27	20 in. by 5-ft. engine lathe
28	24-in. by 7-ft. engine lathe
29	24 in. by 9-ft. engine lathe
30	24 in. by 9-ft. engine lathe
31	24 in. by 9-ft. engine lathe
32	24 in. by 9-ft. engine lathe
33	24 in. by 9-ft. engine lathe
34	10-in. emery grinder
35	18-in. emery grinder
36	50-kw., 500-volt dynamo
37	dynamo
38	10-ft. boring mill
39	18-in. slotter
40	50-in. boring mill
41	10-in. slotter
42	20x48-in. slab miller
43	48x48-in. by 20-ft. openside planer
44	30-in. upright drilling machine
45	30-in. upright drilling machine
46	28-in. upright drilling machine
47	24-in. upright drilling machine
48	30-in. upright drilling machine
49	laying-out table
50	18-in. double-spindle, car-wheel grinder
51	18-in. double-spindle emery grinder
52	pouring table
53	babbitt furnace
54	coal bin
55	30x30-in. by 8-ft. planer
56	10-in. emery grinder
57	48 in. by 18-ft. forge lathe
58	24 in. by 8-ft. engine lathe
59	24-in. by 10-ft. engine lathe
60	36 in. by 20-ft. engine lathe
61	30 in. by 22-ft. engine lathe
62	36-in. radial drilling machine
63	60-in. plain radial drilling machine
64	48-in. plain radial drilling machine
65	hydraulic press for 12-in. wheels
66	250-ton portable hydraulic press
67	8-in. pipe threader
68	12-in. pipe threader
69	welding generator
70	2-in. pipe threader
71	10-hp. motor

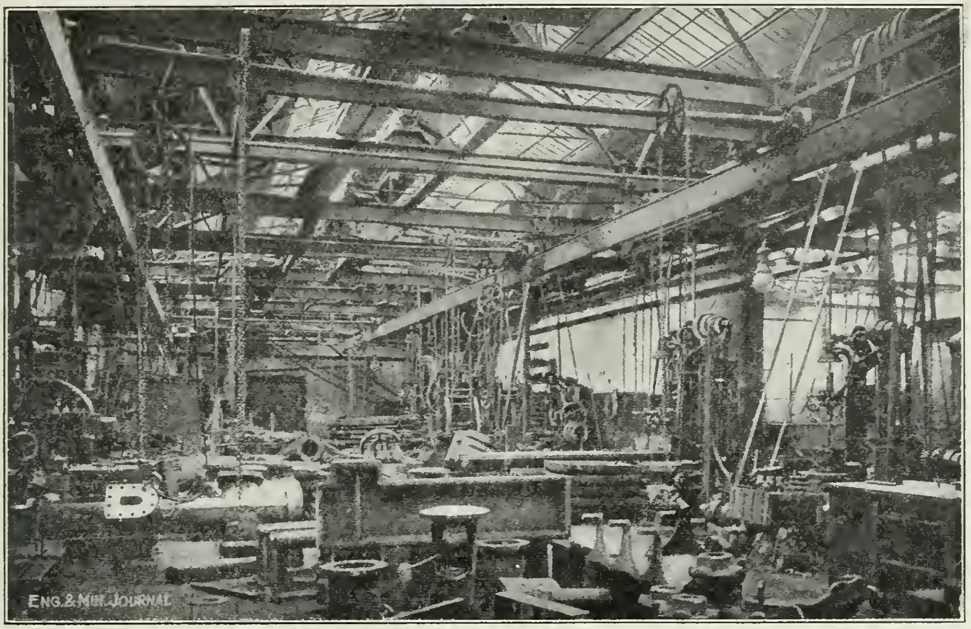


FIG. 3. ANACONDA SHOP.

drills to be fitted up and completed for operation without difficulty.

ANACONDA SHOPS.

Another machine repairing and building plant of large size, connected with the copper-mining industry, is the foundry department of the Anaconda Copper Mining Co., at Anaconda, Mont. This establishment comprises machine and pattern shops, foundry, sheet-metal and boiler shop, blacksmith shop, wood-working shop and other departments. It not only builds and repairs machinery for the various mines and reduction works of the Anaconda company, but also does considerable contract work for outside customers.

A view of the machine shop is reproduced in Fig. 3, and a layout of the entire machine shop with location of all the tools and other equipment is given in Fig. 2. The building is of brick and frame. The main bays are served by hand cranes of 5-ton capacity each, the position of the runways being shown in Fig 2. A complete list of the mechanical equipment is given in the table, the serial numbers corresponding to the numbers on the drawing, thus enabling the positions and dimensions of the various tools to be found at a glance.

The largest of the Anaconda Copper Mining Co.'s shops in Butte, Mont., is that at the Leonard mine. This shop was erected only two or three years ago and is of concrete and steel.

OTHER SHOPS OF THE COPPER COMPANIES.

The machine shop at the reduction works of the Copper Queen Consolidated Mining Co., Douglas, Ariz., is in a building 80x214 ft., with steel frame and brick walls.

At the Mason Valley copper mines, Yerington, Nev., the machine shop, sheet-iron shop and blacksmith shop occupy one building 45x98 ft. The building is of heavy timber construction covered with corrugated iron.

The Lake Copper Co.'s shop, at Lake Mine, Mich., is 24x40 ft. It is equipped with one 21-in. by 12-ft. lathe, one 24-in. by 24-in. by 6-ft. planer, one 16-in. shaper, one 20-in. upright drill press, one 14-in. saw table, one 1½-in. bolt cutter, one emery grinder and one grindstone.

The Bunker Hill & Sullivan Mining & Concentrating Company, at Kellogg, Idaho, has a group of shops comprising, besides the machine shop, a blacksmith shop, car repair shop, equipped with metal shears, punches, etc., a tool sharpening plant and the carpenter shop

The machine and blacksmith shops of the

Federal Mining & Smelting Co., at Wallace, Idaho, are under one roof; the machine shop itself is 58 ft. long by 36 ft. wide. In addition to this there is an electrical shop equipped for repairs, such as armature winding, a sawmill for timber framing, wedge making and general light sawmill work, and mine carpenter shop and framing sheds.

SHORING DIFFICULTIES IN ST. LOUIS SEWER CONSTRUCTION

BY CHARLES C. PHELPS.

The April 16 issue of *Engineering News* contains an article describing very fully the reconstructed Rocky Branch Sewer in St. Louis, Mo. Not the least of the difficulties in carrying on this work was in connection with the shoring of the trench by means of sheet-piling. Both sides of the streets through which the sewer passes are built up with residences and stores, and in many places the material excavated was of loose nature, such as wet and dry sand, as well as quicksand.

The work is near completion on the round, 14-ft. brick sewer. Steel sheet-piling is driven to a depth of 40 ft. or more by means of extension pieces; steam piledrivers on derricks having 50-ft. booms, are employed. Excavation is accomplished by a steam crane with bucket. As the earth is removed, the sheet-piling is strongly braced lengthwise and crosswise by heavy timbers.

After excavating nearly to quicksand, special precautions are necessary, not only to protect adjacent property but also to make further operations possible. Bulkheads of plank piling are built across the trench every 20 ft. or so. These are 24 ft. high and are driven about 9 ft. below subgrade. The bulkhead, 8 in. thick, is composed of bolted tongue-and-groove- piles. The details of the shoring are well illustrated in Fig. 1. With such an arrangement, it is comparatively simple to keep the trench dry and proceed with the work of laying the sewer.

As the completed masonry nears one of these bulkheads, it is not feasible to pull the plank piling until the fill has been at least partly completed, as the heavy cross timbers are partly braced by the piling and must be left to support the steel piling at the sides. The expedient adopted as most practical was to cut off the bulkhead piling slightly below grade and also just below the lower wale, which allows sufficient clearance for the masonry work.

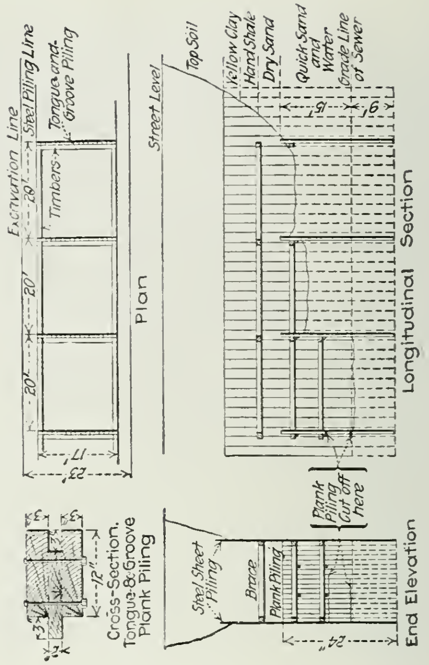


FIG. 1.

The first attempt was to cut off these piles with an ax, but this method was found to be extremely slow and difficult. Large wood chisels fitted to special pneumatic hammers were next tried but without satisfactory results. Circular saws were also considered, but were discarded as being unsafe. Then a 1¾-in. wood-boring auger, operated by a No. 13 size "Little David" compressed-air drill motor, was tried and found to be a very practical means for cutting these thick planks. This motor requires about 30 cu.ft. of free air per minute, which was furnished by a Westinghouse air-brake pump. About seven holes of this size are required to sever a pile and the time consumed in boring each of these 8-in. holes is from 20 to 25 sec. Two or three are required to cut across the pile, so that the entire time consumed in making both cuts across the trench figures ordinarily, between 1½ and 2 hr. The cutting is often in awkward locations and sometimes the tool has to be operated under water.

Similar methods were employed on another part of the sewer which has been completed. There the sewer is rectangular in section to

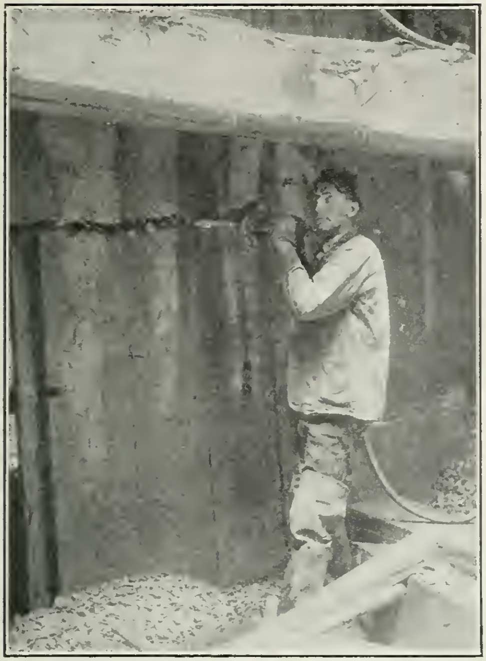


FIG. 2.

save headroom. On that section about 15 ft. of the lower part of the excavation was quicksand. Side piling, composed of 6x12-in. by 20-ft. planks, was driven down 6 ft. below subgrade and served not only as a bracing for the excavation, but also as the outside form for the concrete.

After the concrete had set, these piles had to be removed or cut off just below the street grade. As they were embedded quite deeply and were needed to prevent settlement of the adjacent ground, it was impractical to remove them, and the city permitted the contractor to leave them after cutting off the upper ends There were about 1500 of these piles and a pneumatic wood auger was employed, as previously explained, for cutting off the piles about 10 in. below the pavement. It required from 16 to 20 sec. to bore each 6-in. hole making the time for boring 7 holes, to cut one pile, 1¾ to 2½ min.

The above described work was done by the James Black Masonry & Contracting Co., of St. Louis. The writer is indebted to G. W. Winslow, of St. Louis, for most of the data contained herein, as well as the view.

AIR PRESSURE IN THE NEW YORK SUBWAY

BY FREDERIC CAMPBELL, SC.D.

All who ride in the New York city subways have experienced a strange discomfort in the ear at various times, not always the same, and most pronounced in passing into and through one of the tubes leading under the river. This is due to the compression of the atmosphere produced by the train's motion; and it is felt most in the tubes because they are more confined, there being insufficient outlet for the air's escape. It is said that in the tubes of the Pennsylvania Railroad, passengers manifest particular sensitiveness, as indicated by unusual effort at swallowing; to this they are prompted because of the Eustachian tube, connecting the throat with the inner ear; it is an effort to equalize the pressure on both sides of the eardrum.

The aneroid barometer, so sensitive that it will often move its needle when even carried from the first to the second story, is well fitted to record and measure the variations of air pressure on moving trains in subways; and the writer recently made the experiment with a Tycos instrument. It is easy to believe that, if he had stood at the very front of the train, with the door closed behind him, so that no air could escape through the car, he would have found the needle indicating greatly increased pressure, that is, showing a higher record, as if one had descended to lower levels, where the air is always more dense. And, if he had stood at the extreme rear of the train, with the door closed behind him, so that no air could sweep upon his instrument from the interior of the cars, a much lower record would have been read, as if one had ascended to some lofty hilltop, where the air strata are more rarefied. Directly in front of every swiftly moving train, particularly if confined in a tube of small caliber, the air is being forcibly packed into a condition of great density; while directly behind it, the recession of the train is leaving the air behind, causing a partial vacuum.

But, these facilities not being granted to passengers, experiments can only be carried on within the cars; these, being open at ventilators or windows, afford good opportunities, as one's sense of discomfort in the ears may well assure us. The experiments in going were made in the front car, and in returning in the rear car. The trip going was from Borough Hall, Brooklyn, over the Broadway line to its terminus at 242d street. The trip returning was from 177th street of the Bronx line back to Borough Hall, Brooklyn. As the barometer was found to stand exactly the same at Borough Hall on the return as at the start, it is apparent that weather conditions had not materially changed. The following table shows the readings, as recorded in the inches of the mercurial barometer column; the first column should be read down; the second column should be read up; this arrangement enables one readily to make comparisons.

	Front of first car, Broadway line, going.	Rear of last car, Bronx line, returning.
Borough Hall	29.84	29.84
Entering tube	29.90	29.88
Highest tube pressure	30.05	29.90
Lowest tube pressure	.....	29.84
Bottom of tube	.....	29.87
Bowling Green	29.90	29.88
Wall Street	29.87	.....
Between Brooklyn Bridge and Fourteenth Street	29.84-29.89	.....
Fourteenth Street	29.86	29.85
Between Fourteenth Street and Grand Central	29.84-29.87	.....
Grand Central	29.84	29.83
Between Grand Central and Seventy-second Street	29.80-29.86	.....
125th Street	.....	29.85
Between 149th Street and 135th Street	.....	29.82-29.87
Third Avenue and 149th Street (subway begins)	.....	29.84
177th Street, elevated platform, open-air	.....	29.78
242nd Street, elevated platform, open-air	29.82	.....
242nd Street, street level, open-air	29.84	.....

From the above figures the reader may draw his own conclusions. Looking them over, however, it is manifest that, within the train, there is not the difference in pressure that the ear discomfort seems to indicate. The very highest figures here given are 30.05, and the lowest 29.78, a difference of only 0.27 of an inch on the mercury scale. Every subway traveler knows how quickly the ear discomfort is relieved, even while still closely confined in the tube. It is conceivable, however, that, with the swift rush of the train, barometers in different cars and even in different parts of the same car would read differently at the same instant; with the whirl of the atmosphere, there may easily be dense spots and also rare spots or "pockets;" and the action of the aneroid barometer is not sufficiently prompt in its response to rapidly changing conditions.

Enough is shown, however, to support the theory that there is condensation at the front and rarefaction at the rear of a subway train, and that this is particularly marked in the close limits of the river tube. The highest pressure was shown in the front car going, while in the tube; and, in the rear car, returning in the same conditions, the instrument recorded 0.21 of an inch less pressure. From this it would seem that relief from ear discomfort might well be expected at the rear of the train, and that this relief may be expected in increasing degree as one selects his seat farther from the train front.

The high reading at bottom of tube is partly due to the low altitude; for there we are below sea level, and not a few feet beneath that of Borough Hall and the subway generally. Some other variations of reading are doubtless also due to variation of level rather than to differences of air pressure caused by the motion of the train. Where two or four tracks spread out across the subway, there is such opportunity for the air to escape that the barometer is not commonly affected; yet in the rush and whirl of swiftly passing trains it sometimes shows considerable uneasiness.—*Scientific American.*

[It will be noticed that in the "going" trip the greatest pressure difference was 0.23 in of mercury, while in the returning trip the difference was only 0.12 in., the former of these corresponding to an altitude pressure difference of about 230 feet. There are tall buildings in New York where an aneroid barometer carried in the elevator will shown a pressure difference more than double that observed in the subway.—Ed. C. A. M.]

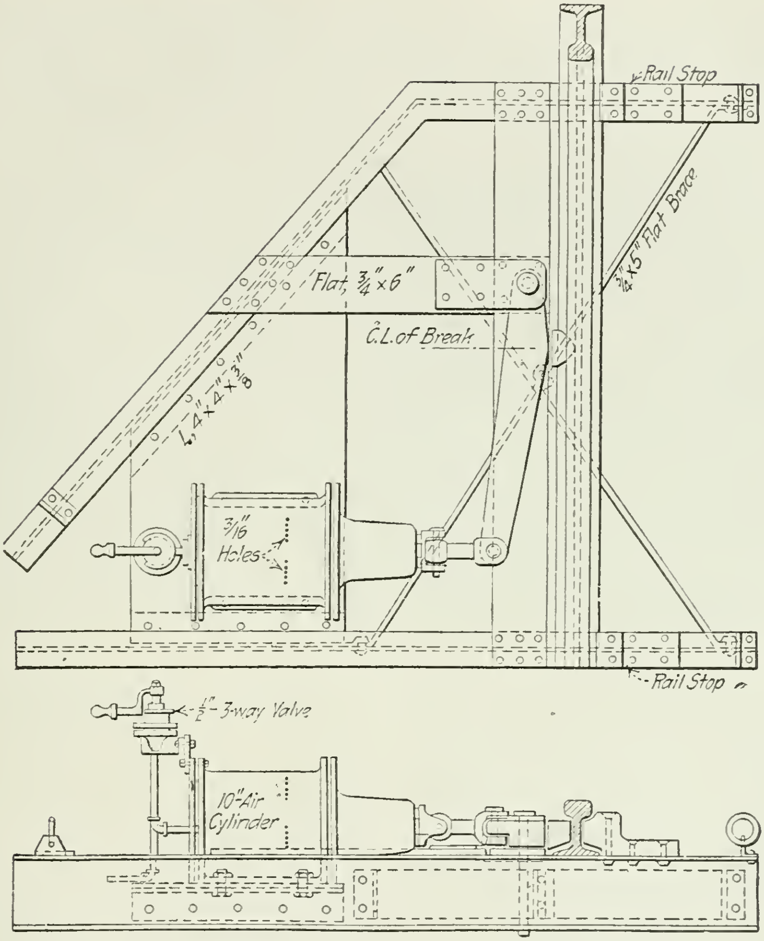
VELOCITY AND PRESSURE OF WIND

From experiments by the U. S. Weather Bureau it was found that the relation is best expressed by the formula

$$p = 0.004 \frac{B}{30} v^2$$

Thus, for a velocity of $v = 60$ mi. per hr., when the barometric pressure is $B =$ say 28 in., the pressure of a straight wind, normal to a flat surface, is

$$p = 0.004 \frac{28}{30} 60^2 = 13.44 \textit{ lb. per sq.ft.}$$



A PNEUMATIC RAIL BENDER

The cut shows the essential features of a press made and in use at Balboa, Canal Zone. for the lateral bending of steel rails. The rails treated are mostly old rails used for reinforcement in the concrete construction of Dry Dock No. 1.

A 10 in. air cylinder, with 10 in. stroke, is mounted on a base built of braced 8 in. I beams covered with 3/4 in. steel plates. The piston rod is connected to the end of a horizontal lever 2 ft. 4 in. long, the other end of which is set in a stationary pivot alongside the rail. Near the pivot end a wedge shaped block of steel is attached to the bar, the other face fitting the shape of the side of the rail to be bent. A forward stroke of the piston thrusts the wedge shaped block against the web of the rail midway between the two equi-distant rail stops on the sides of the base, the thrust being sufficient to bend the rail to a considerable curvature if so desired. When the stress is on the rail it can be broken by a sharp sledge blow opposite the point of contact of the block, which is a rough way of cutting the rails to lengths desired. The machine is portable, weighing about 650 lb., and it can be supplied with air by power connection to the air brake system of a locomotive or train

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The ashes which still largely cover Herculaineism and Pompeii contain large quantities of potash and clay from which an excellent fertilizer can be obtained, and it is said the Italian government is seriously planning the exploitation of this undeveloped wealth.

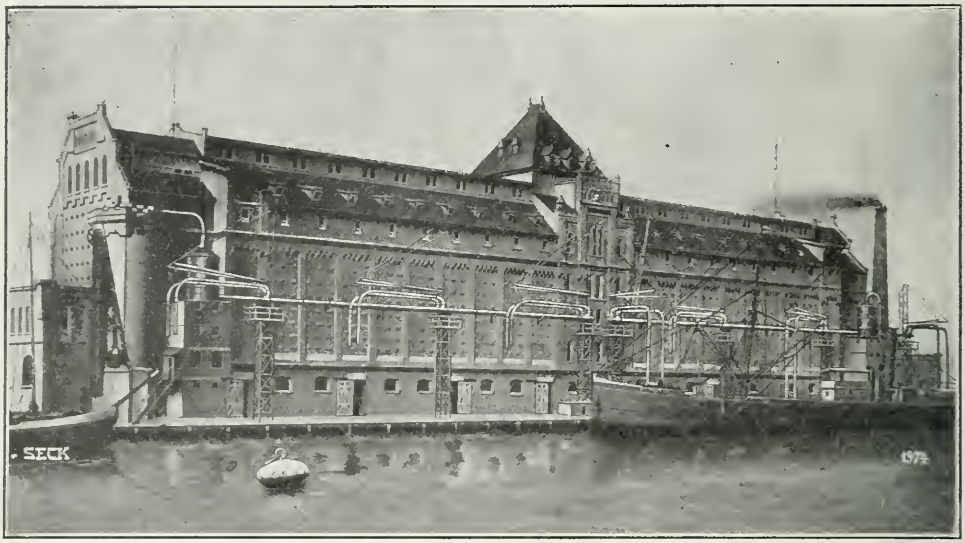


FIG. I.

PNEUMATIC GRAIN AND COAL CONVEYORS IN EUROPE

The pneumatic conveying of grain and similar fine, dry materials from boats or cars to warehouses or elevators, or vice versa, is now so established in Europe that more than one firm is employed in the business, the systems employed differing somewhat in details of construction or operation. The system is especially valuable where obstructions are to be avoided in reaching the point of delivery, the conveyor pipes being arranged to go over, under or around such obstructions to distances exceeding 1000 feet and to heights as great as 150 feet.

Following the information upon this subject contained in our August issue, the half tone on this page shows an interesting installation of the Seck system at Amsterdam. By this arrangement grain is unloaded from boats on one side of the building and stored in the elevator or is delivered upon cars at the rear of the building. The plant consists of two similar portions, making in fact two distinct pneumatic plants, each laid out to handle upwards of 100 tons of grain per hour.

At each end of the building is an air pumping plant and a receiver into which the grain is first delivered. At the corner of the building, in the left foreground, is a round iron tower in the upper part of which the receiver is placed, this being connected with the air pumps and with the suction pipes which bring the grain.

Seven lattice work steel towers are located along the water's edge, each of these carrying two pivoted suction tubes which with their connections can be led into the holds of vessels alongside. At the middle of the building two of these towers come close together so that they can both operate on the same boat. Upon the towers are winches for manipulating the tubes as desired. The wheat passes along the horizontal pipe and is delivered into the receiver at either end; then it is dropped into a special grain holder from which it goes to the scales. From here it goes to main bunkers from which it is distributed as desired by belt conveyors or bucket elevators.

Fig. 2 shows the Seck pneumatic system employed for unloading coal at a large German brewery.

In an English mill at Ipswich the question of handling the grain was relieved of its difficulties by the employment of the pneumatic system. Here the building lay near the water's edge, but the street and an electric trolley line ran between, so that the usual conveyor methods could not be employed, and the street could not be bridged. It was a simple matter, however, to lay a pneumatic tube under the street and thus reach the boats

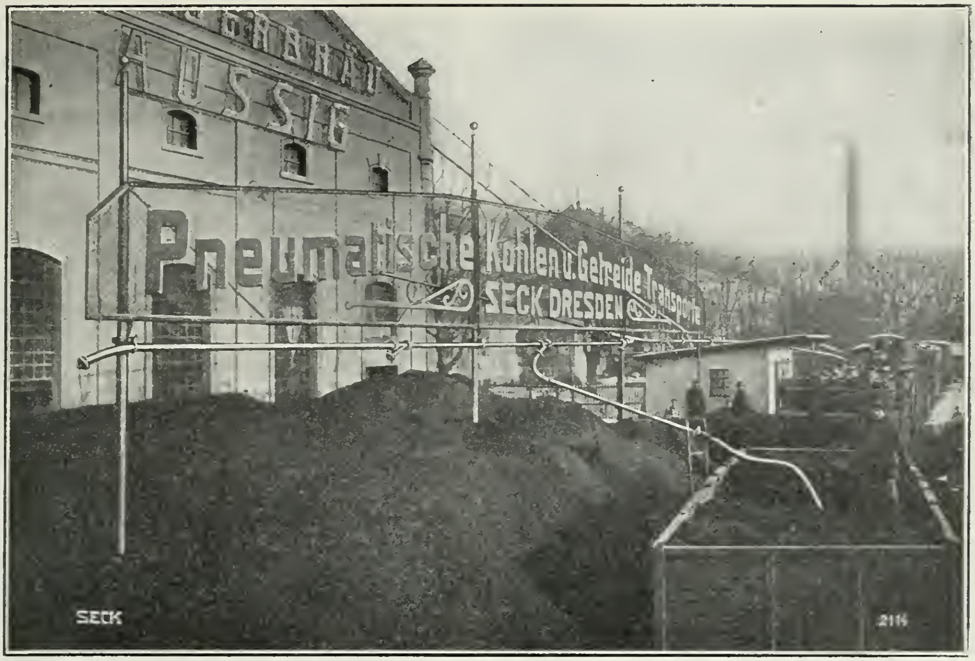


FIG. 2.

INCREASING COMPRESSOR CAPACITY BY COOLING INLET AIR

BY L. D. ANDERSON.

In the installation of air compressors, a method of increasing their capacity is often overlooked, although well recognized by engineers. It may be stated that the capacity of a compressor with inlet air at 90° F. is only about 95% of its capacity with an inlet temperature of 60° and about 90% of what it would be if this temperature were 32°. Frequently the air for compression is drawn from the engineroom itself or from the sunny side of the building.

At the Centennial-Eureka, Utah, the master mechanic, James Knowles, hit upon the scheme of drawing his inlet air from an old tunnel extending into the hill alongside the compressor house. In the tunnel the air in the summer time was always much cooler than outside. The use of this cool air resulted in a perceptible increase of compressor capacity, the machine running noticeably slower after the innovation was adopted.

Undoubtedly many mines could obtain for their air compressors a similar source of cool air. If the tunnel be any distance from the compressor house, it is advisable that the air conduit be a wooden box to avoid heating, with a cross-sectional area large enough to eliminate losses due to the possible creation of partial vacuums, as might happen in smaller conduits; it should probably be equal to the area of the piston. The adoption of such a scheme will help to keep up the air pressure in the day time when all the drills are running and may besides save some fuel.

DECLARATION OF WAR ON THE GASOLINE CAR

Dr. Charles P. Steinmetz, of the General Electric Company, than whom there is no one who can speak more authoritatively upon the subject, predicts that within ten years there will be in operation not fewer than one million moderate priced electric vehicles whose approximate price will not exceed $500 with a speed certain to average 20 miles per hour. Against the gasolene cars he claims the disadvantages of fuel and oil costs, the concentration necessary in driving a high powered machine and the need of constant attention to its engine. "Within a decade," he says, "the gasolene car will be relegated to the limbo of things outlived."

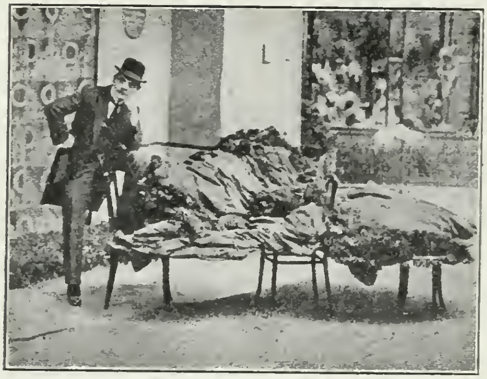


FIG. I.

SOME THEATRICAL TREE TRUNKS

The three half tones on this page, kindly sent us by a correspondent in Germany, seem to require not a word in the way of explanation, as they tell the whole story, which, by the way, may be read either forward or backward. The difference between the state of full inflation and that of complete collapse, or *vice versa*, might be used by a sermonizer in various ways. The air pressure employed is furnished by a fan blower, its services being employed for various other details of stage scenery.

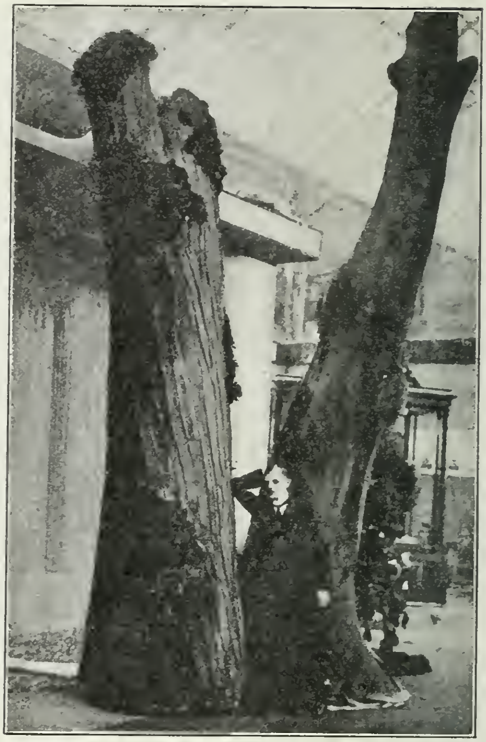


FIG. 3.

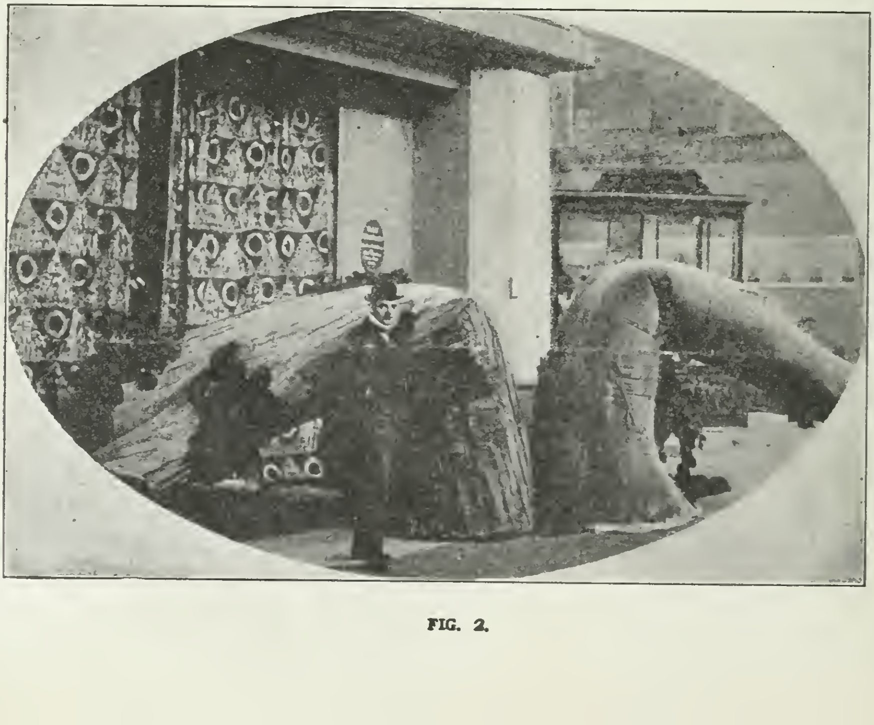
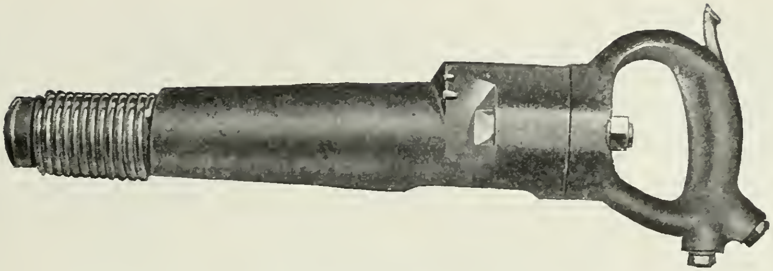


FIG. 2.



LITTLE DAVID WITH SAFETY RETAINER.

SAFETY FIRST IN PNEUMATIC RIVERTERS

Following the recent "Safety First" movement, several states are drafting safety appliance laws, among the provisions of which are requirements that riveting hammers embody in their construction devices to prevent the accidental ejection of the rivet set from the nozzle of the hammer. One of the most novel rivet-set retainers is that now put out with the "Little David" pneumatic riveter, shown above.

The retainer consists of but a single piece of heavy spring steel, closely wound into a spiral form. One end of this spring fits over the outside of the hammer nozzle and hooks over a projection integral with the nozzle. The other end is wound to a smaller diameter. Sets for rivets over ⅞-inch diameter are formed with a coarse thread and are simply screwed into place. Sets for rivets ⅞-inch diameter and smaller are formed with a shoulder and are slipped into the retainer while it is detached from the hammer, the shoulder holding it in place. The device prevents the rivet set or piston from being driven out, even when the hammer is run free.

Other important improvements have been embodied in the "Little David" riveter. There is but a single metal-to-metal joint between handle and barrel and these parts are securely held together by two bolts, one on either side of the barrel. This construction eliminates the need of a vise in taking the tool apart for inspection.

The temperatures at which certain substances, in contact with atmospheric air at ordinary pressure will catch fire, as found by Dr. H. Holm, are as follows: Lighting gas, 1112 degrees, Fahr.; benzine, 779; petroleum, 716; gas oil, 662; machine oil, 716; coal tar, 932; tar oil, 1076; benzol, 968.

CLEANING PAVING BRICK.

CLEANING OLD PAVING BRICK BY COMPRESSED AIR HAMMERS

BY CHARLES S. BUTTS.

The construction of the Rocky Branch joint district sewer at St. Louis, Mo., involved the disturbance of a considerable extent of paved street. The work is 5724 ft. long and was done by the James Black Masonry & Contracting Co., at a price of about $500,000.

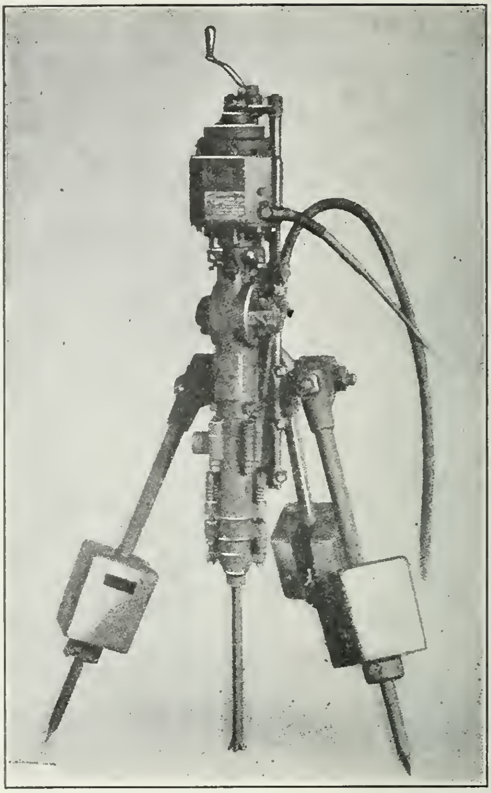
Of the total length, 4600 ft. was in streets having brick paving grouted with cement, the paved width being 17 to 30 ft., and the total paved area being about 10,000 sq.yd., with about 530,000 brick. The specifications require the contractor to repave the streets and leave them in as good a condition as before the construction of the sewer.

The question was (and always has been) whether it pays to clean vitrified paving brick (cement grouted) for use in repaving streets. In cleaning them by hand a man can clean about 300 a day. And at $4.50 per 1000 (which was paid for this method of cleaning) he would only make $1.35 a day. In order to make it any inducement to clean them by hand about $9 per 1000 would have to be paid. The contractor finding this method not only slow but also unsatisfactory, abandoned the hand-cleaning method and adopted the following machine method which has proved very satisfactory.

An old vacuum-cleaning wagon was obtained and set up in a convenient location at the pile of brick to be cleaned and used as an air compressor. A ½-in. supply pipe was run to a cleaning board, and to it were connected ¼-in. hose, to each of which was attached a 6½-lb. stonemason's vibrating air hammer. The hammers had 1-in. chisel points for cleaning the portland-cement grout from the brick. A bench was built and about 70 bricks placed on it with the side upward. One side and one end were cleaned first; then they were turned and other side and other end was cleaned. As there was no cement on top or bottom it required only one turn to complete the cleaning. The capacity of this particular machine is three hammers, and, as the following table shows, the more hammers operated, the cheaper the brick can be cleaned.

	1 hammer	2 hammers	3 hammers
No. brick cleaned per day..	1200	2400	3600
Cleaning brick, $2 per 1000.	$2.40	$4.80	$7.20
Turning brick, $1 per 1000..	1.20	2.40	3.60
Gasoline for machine.......	1.40	1.40	1.40
Cost	$5.00	$8.60	$12.20
5% for care of tools, etc....	0.25	0.43	0.61
Total cost	$5.25	$9.03	$12.81
Cost per 1000 brick.........	4.375	$3.762	$3.3558

The difference in cost per 1000 is due to the gasoline used, it costing $1.40 per day to run the machine whether one, two or three hammers are used. To the above costs per thousand for cleaning must be added about $2 for hauling to the pile and back on the street, which would make the cost (using the two-hammer price) $5.76 per 1000. This against $16 per 1000 for new brick makes a saving of $10.24 per 1000 for the small-size brick (2¾x4x8¼ in.). The large paving brick now in use (3¼x8½x4⅛ in.) would cost about $4.50 per 1000 to clean, plus $2 for hauling, making $6.50 per 1000 against $22 for new brick, a saving of $15.50 per 1000.—*Eng. News.*

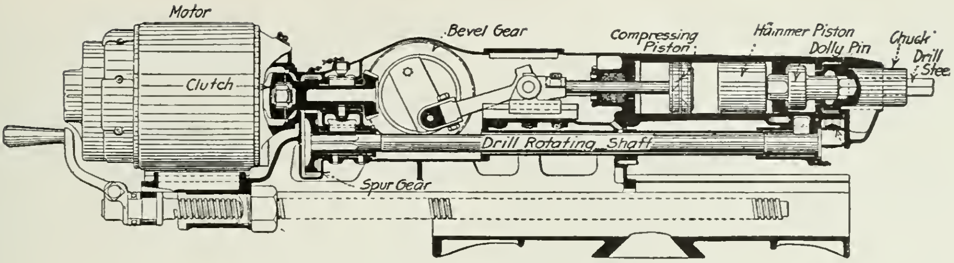


PNEUMATIC ELECTRIC HAMMER DRILL.

AN ELECTRIC AIR HAMMER DRILL

The machine here shown, Fig. 1, is essentially a hammer drill, as distinguished from a drill having a reciprocating piston which carries the steel bit with it. In this case the bit is stationary and is struck successive blows by a reciprocating hammer with the intervention of an inert anvil block between them The principle of operation of this drill cannot be said to be new, the present device being a development of a type which has been known for several years.

Instead of actuating the hammer by direct air pressure from some constant source of supply, as in the more familiar types of pneumatic hammer or other drills, this machine may be said to be its own compressor. Referring now to Fig. 2, the cylinder in which the hammer piston works is elongated behind this piston, and in this elongation of the cylinder there is an air compressing piston which is reciprocated by connection with a crank whose



PLAN OF PNEUMATIC ELECTRIC HAMMER DRILL.

shaft is rotated, through suitable reducing gears, by an electric motor, all the apparatus here enumerated being integral parts of the complete drill as actually set up and operated.

The compression of the air for each hammer stroke is done in the end of the cylinder to the left of the compressing piston as here shown, or what would be the upperend of it in Fig. 1. With the parts in the position shown in Fig. 2 it is to be assumed that the hammer piston has just struck its blow upon the dolly pin and that the compressing piston is approaching it, the air between the pistons running through passages at the side to the upper end of the cylinder. When the compressing piston has completed its stroke, closely approaching the hammer piston, and commences its return stroke the hammer piston follows it, being driven in that direction by the atmospheric pressure behind it. During this movement of the pistons the air is being compressed and this compression continues until when the stroke is nearly completed holes placed in a ring around the cylinder are uncovered by the advancing piston and the compressed air suddenly shoots between the pistons causing the hammer piston to strike its blow. No valve motion is required, the air distribution being accomplished by the successive uncovering by the pistons of two rings of holes around the cylinder. It will be seen that advantage is taken of the expansive force of the air in making the hammer stroke so that, barring the inevitable leakage, the air may be claimed to be applied economically Although the hammer must make a stroke for each rotation of the crank shaft the speed of that rotation must be limited by the sufficiency of the atmospheric pressure to return the hammer piston. A maximum working air pressure of about 60 lb. gage is reached in working

The drill as shown is fitted for the use of hollow drill steel and wash water continually supplied. Water may be delivered from pressure lines when convenient, but there is a small pump on the main gear spindle and the discharge is piped to the drill chuck chamber. The steel is rotated a fraction of a turn after each blow, the chuck having a ratchet connection to a small crank arm on a long shaft running to the motor gear, connecting with the latter by spur pinion and gear.

The machine is built by the Pneumatic Machine Company, Syracuse, N. Y.

PNEUMATIC VERSUS ELECTRIC MOTOR STARTERS

BY WILLIS A. SWAN.

There are in action two kinds of starters. We will call them continuous and intermittent. The first named type is one which starts the engine and keeps revolving it until motor ignites and takes hold itself.

The second named is one that gives the motor from one-fourth to three or four complete revolutions and then stops, to be repeated if motor has not ignited and taken hold itself. At first glance the continuous type seems to have the advantage, but, after considering the question from different angles, I believe the intermittent starter will show its superiority, especially after some use, providing, of course, it is properly designed; for instance, the owner of a car fitted with a continuous starter will start the mechanism in operation and will continue to let it run until the motor starts, regardless of the condition of the valves, the carbureter, ignition, or anything else, providing it will start before his motive power is exhausted, thinking that probably the fault of its not starting quicker lies in the starter itself, the battery or the wiring. It never occurs to him that a little adjustment to the motor will overcome the evil

With the intermittent starter, a man r

ceives his car, he knows positively that it will start the first or second time he operates the starting mechanism. After 4 or 6 months' use he is obliged to operate six or eight times before motor starts. He naturally begins to know things are not what they were, and upon investigation it is found that the adjustments required to place it in the original condition are few and inexpensive. There will be a difference of opinion on this matter, but this is my experience with both methods in the hands of users.

ELECTRIC OR PNEUMATIC?

Now as to the advantages of electric or compressed air as a motive power, for the necessary service required on a modern car, it is only logical to reason that the most successful system is that which is the cheapest to install; the simplest and the most durable in operation, the lightest in weight and the easiest to be repaired. In considering such a system, let us remember that the automobile is a mechanical institution and just as soon as you begin adding anything foreign to mechanical movements, you begin to complicate. For instance, if a machine is 100 per cent. mechanical, a mechanic can repair the machine. But if it is 95 per cent. mechanical and 5 per cent. electrical, then it requires both electrical and mechanical experience. Therefore, it seems that the most desired machine would be that which is wholly mechanical. In designing a service for an automobile, I wish to state that it is only after considering every feature and every point of advantage of both systems, that I make this comparison.

The necessary requirements for an up-to-date automobile are as follows:

First: It should have electric lighting.

Second: It should have a self-starter.

Third: It should have provision for inflating tires.

Fourth: Provision for signal operation.

Fifth: A constant pressure on gas tank.

Sixth: A uniform flow of oil for lubrication.

Seventh: Provision for dusting and cleaning seats and mechanism.

There is also a possibility of air brakes and air cushions, which would be lighter and better than those at present used.

In considering electricity, we have three of the above requirements, which electricity, when used as a primary power, will answer, and four that electricity will not answer. Considering the compressed air, we have six requirements which compressed air will answer and only one that it will not answer, but with a single, small generator for lights, it will give all of the required service mentioned with less cost, less weight, less expense, less complication, less attention and greater reliability than electricity. A comparison of the two systems, I believe, will prove my claims.

NECESSARY ELECTRIC EQUIPMENT.

To obtain the above service in the simplest possible manner, using electricity as a primary power, we would require the following apparatus:

First: A generator connected to motor, which runs continually while motor runs, always forming a drag, and only charging battery when running at certain predetermined speeds, which weighs approximately 30 pounds and costs the manufacturer about $35.

Second: A storage battery which requires more or less attention, always liable to short circuiting, sulphating, buckling, etc., which weighs approximately 30 pounds and costs $15.

Third: A motor built in the car, with gearing clutches and suitable relieving mechanism, which will not revolve engine at a greater speed than from 90 to 120 revolutions per minute, and which weighs approximately 45 pounds, develops 1 horsepower and costs about $40.

Fourth: A Klaxon or similar signal, weight three pounds, approximate cost $10.

Fifty: An air pump, connected with motor for producing pressure in air tank, for tires, etc., weight about 10 pounds, price $15.

Sixth: An air tank for air storage, to be used for tire inflation, cleaning, gas tank, etc., weight 20 pounds, costing $3.

The complete outfit to weigh approximately 138 pounds and costing $116.50.

COMPRESSED AIR REQUIREMENTS.

Using compressed air to obtain the same service, we require as follows:

First: A generator, direct connected with a small air motor and placed in a convenient position, which may be a self-contained unit, not connected with engine, which may be removed and replaced in 10 minutes and which runs only when lights are required, with no drag on engine. The approximate weight of which is 20 pounds and costing about $25.

Second: A self-contained starter, capable of turning the engine over at a speed equal to 300 revolutions per minute and developing 3 horsepower, is entirely self-contained, capable of being removed in 10 minutes, and replaced in the same length of time, entirely dustproof, with no brushes, commutators, wiring, or delicate mechanism to get out of order, which weighs 40 pounds and sells to the manufacturer for less than $25.

Third: An air pump connected with engine, with an automatic regulator, that keeps air at a predetermined pressure, always the same in tank. Weight 20 pounds, cost approximately $15.

Fourth: A tank for air supply, weight 20 pounds, cost $3.

Fifth: A signal which may be Klaxon principle or otherwise, weight 2 pounds, cost $4. Total weight approximately 102 pounds and cost $72, making a difference of $44 in cost of compressed air and 36 pounds in weight in favor of compressed air.

The complete installation requires 6 tubes and is so simple that any ordinary mechanic can repair it with a few minutes' study.

ELIMINATING THE WIRES.

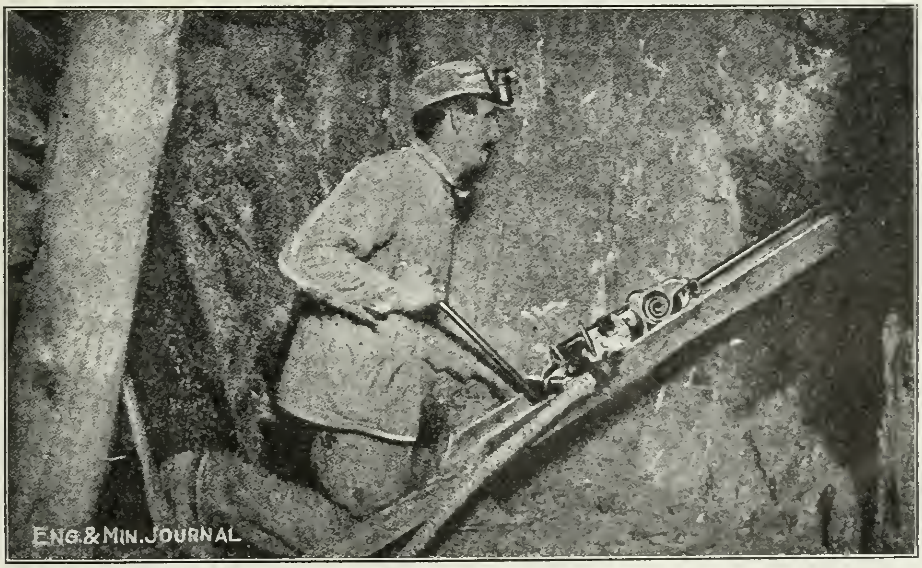
You will notice I do not mention the number of wires, at least twenty to thirty, which are liable to breakage and short circuiting, caused by oil rotting the insulation or otherwise; the cost of upkeep and maintenance; also its adaptability from manufacturer's standpoint, all in favor of compressed air.

In conclusion, let me say that in comparing the two new systems, it will be noticed that in the case of the electric installation I have given figures unusually low, so much so that I hardly think there is a manufacturer of electric lighting apparatus who will attempt to meet the prices, whereas in the case of the system described it is possible to obtain such apparatus at the prices quoted, and, while in many cases at the present time such service is sold as extra equipment, it is only a short time before the public will demand such service as regular equipment on all cars selling as low as $500.—*The Automobile.*

DRIFTING WITH A JACKHAMER

BY I. A. CHAPMAN.

Three men, leasing a mine in Butte, are drifting and doing all their drilling with a jackhamer. They are Dick and Harry Cloke and Harry Andrews, each one of whom had considerable experience with jackhamers, while operating a lease on the Bullwhacker property. On the mine which they are working at present, they are driving a 7x7-ft. drift on a vein varying from 18 in. to 7 ft. in width and dipping 35°. The wall rock is so solid



JACKHAMER AND TROUGH.

that little timbering is necessary. The rock is the easily drilled quartz monzonite of the Butte district, altered principally by the formation of chlorite. The men preferred the jackhamer, although they had the choice of any other machine.

An important item of equipment is the wooden trough in which they seat their drill. This is about 6 ft. long with inner side boards to hold the drill as steady as possible. It is laid up against the breast in line with the hole to be drilled, the machine is placed in the trough and the drilling commenced. In order to hold the machine up to its work, it is urged forward by a lever consisting of a short piece of steel, which fits into holes drilled in the base of the trough. Six 5-ft. holes are generaly drilled to the round. In harder rock it is sometimes necessary to drill back holes almost flat. This is done by wedging a small stull across the drift 4 ft. from the face at the desired height and spiking the rear end of the trough to the top of the stull.

The average time for drilling a 5-ft. round of six holes is 2 to 2½ hr.; the men relieve each other and keep drilling steadily during that time. A special feature of the steel used is a hole 4 in. back of the bit slanting backward and connecting with the center hole of the steel. This extra hole aids in the blowing out of drill cuttings. I believe that this is an idea of Oscar Rohn's, or at least, that he was the first to use it in Butte.

Twenty-four to 26 cars of rock are broken per round. The cars are trammed an average of 300 ft. to the shaft. In order to make the handling of the cars easier, the drift was widened in two places, and switches put in. It was necessary to timber the drift in one place for a distance of 30 ft., where two turns were made. With the exception of running the hoisting engine and compressor and doing a small part of the drill sharpening, the three men do the work, including dumping the cars on the surface. At the end of 25 shifts they had made a progress of 94½ feet.—*Eng. and Min. Journal.*

COOLING AND DRYING AIR

The cooling of air economically has presented a difficult problem, because it has been necessary to rely largely on plants with a comparatively heavy first cost, and requiring careful attention during working. A system has been introduced recently, however, which relies not only on the cooling effect of water, but on the principle of evaporation for abstracting heat from the air, and is based on the design of a water-atomising spray, which breaks the water into a fine cloud or vapour so that the air is washed of impurities, and the evaporation produced is instrumental in causing a fall in temperature, apart from that produced by the cooling effect of the water. It is possible with this system, we are told, to cool air to the temperature of the cooling water by using less than one gallon of water per hour for every five cubic feet of air per minute for quantities up to, say 1,000 cubic feet of air per minute. A pressure fan is required for driving the air into the building, mine or other place to be cooled, but apart from cubicle through which the air passes, to- this the device consists only of a chamber or gether with a system of sprays and the necessary inter-connecting pipe work. The chamber can be built of brick work lined with waterproofed concrete or reinforced waterproofed concrete or of wood, waterproofed and rendered watertight. It is stated that the sprays only require a pressure of 30 lbs. to the square inch, so that they can usually be worked from town mains, or a small pump connected to a river or well and driven by an electric motor or other prime mover.

LONGEST TUNNEL IN AMERICA

The Mount Shasta Power Corporation is pushing construction on a seven-mile tunnel to carry water from the Pitt River, in Shasta County, Calif., to the forebay of its projected power house. The tunnel so constructed is to be 7 ft. wide and 9 ft. high. Later it will be enlarged to a width of 16 ft. and a height of 19 ft. Crews are working at both ends, the aggregate length of the two sections now being a little over a mile. The entire length will be completed as a 7x9-ft. section before the bore is enlarged

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The melting points of some metals which fuse at very high temperatures are as follows: Titanium, 1,795° C. (3,263° F.); vanadium, 1,720° C. (3,128° F.); chromium, 1,520° C. (2,768° F.); manganese, 1,260° C. (2,300° F.); iron, 1,530° C. (2,786° F.); cobalt, 1,478° C. (2,692° F.); nickel, 1,452° C. (2,645° F.).

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MAKING THE BEST OF IT

It is impossible to ignore the conditions which now confront the world; but who knows what to say? When was it ever more difficult to accept what our eyes and ears too plainly tell us? Can it be that just a hundred years from Waterloo, at the completion of a century of marvelous achievement and progress in art, in science and in the ways and means of doing things, with constant accumulation of the enduring products of industry, and ostensible talking and planning for universal peace, the climax of it all is to be the most gigantic war of all the ages?

It looks so as we write. And how could it be otherwise? Constant planning and scheming as to war possibilities, constant accumulation of war material, constant piling of invention upon invention with sole intent to destroy, what could it all lead to but war, and war commensurate with the accumulated facilities for war?

When a man carries a gun "for self protection," it is the universal experience that the gun is vastly more likely to produce than to prevent trouble and disaster; and so it has been found wise and in the interest of public safety to prohibit the carrying of weapons Unfortunately, however, the head of a nation who rules "by divine right" is above all human police. He can build a navy such as never was until these latter days, and he can make all the men of his nation into a world-terrorizing army, and then others also can feel compelled to arm to the utmost in preparation for his breaking out.

The inevitable seems to have fallen, and that is as far as our vision extends, the above being mostly the impression of a single individual. As to what right or necessity there may be for it all, little good can come of discussing it now. We, however, cannot be disinterested onlookers, as world interests are involved and there must be an overturning and a reconstructing of many existing relations It is for us to be optimists rather than pessimists, and much there is to cheer and sustain us if we persistently look for that. We are rich in this world's goods and have the rich man's advantage. Fighters must eat and we can feed them. The disorganization of foreign manufacture removes competitors in a way we would not rejoice at but are bound to take advantage of. We can have exclusively now the trade of non-combatant nations where once was sharp competition. We can learn and appreciate how more completely than any other nation we are self-sustaining and independent.

WASTE OF AIR IN DRIVING STEAM PUMPS

Editor Compressed Air Magazine:

In the August issue of your valued publication, on page 7302, appears an article by Mr B. B. Hood, entitled, "Measuring Compressed Air for Cost Distribution." In this article, on page 7303, second column, paragraph beginning "Pumping water with air is expensive" and then he goes on to say that he uses a No. 10 Cameron pump, 14 and 8x13″ to pump water. The total pumping head of the pump, including suction and pipe friction, being 103.1 feet.

A simple calculation reveals the fact in a 14″ cylinder the theoretical pressure required to overcome this head with a 14″ air piston and 8″ plunger would be 15 lbs. Certainly 25 to 30 lbs. would have been ample. The article in another place states that the air was compressed to 75 to 80 lbs. To compress air to 75 or 80 lbs., requires roughly twice as much power as would be required to compress air to 25 or 30 lbs., so that in the instance Mr. Hood cites compressed air pumping is just twice as expensive as it ought to have been if a little ordinary good sense was applied, and three or four times as expensive as it should have been if some real engineering ability was devoted to the problem.

Why should people be allowed to make such statements as "Pumping water with air is expensive," when the opening of this paragraph should read "Pumping water with air is expensive when, as in this instance, it is done in a foolish way, and by means of apparatus which is absolutely unfit for the purpose."

C. B. Hodges.

[Too much cannot be said against the all too common practice of driving steam pumps by compressed air. The arrangement is extremely wasteful at the best, and in addition to this, as pointed out by our correspondent in this case, the cylinder raties and the air pressures are such as to make a bad matter worse. The article referred to by our correspondent, however, was dealing with the measuring of the air used, and not the most economical employment of it.—Ed. C. A. M.]

LATEST COMPRESSOR PHENOMENON

The following letter speaks for itself:

"The writer is not familiar with the science of compressed air and would very much appreciate your expression in regard to the market for a hand compressor weighing twelve or fifteen pounds that compresses air up to six or seven hundred pounds without generating sufficient heat to even warm the cylinder. I do not know whether this statement is out of the ordinary, hence anything you can say on the subject will be appreciated."

Replying to the above we have to say that we do not know what market there may be for devices which will do impossible things. It is beyond all controversy that air cannot be compressed without raising the temperature of it. For instance, if air at ordinary atmospheric temperature and pressure is compressed to, say 600 pounds, its final temperature if it could be prevented from giving up any of its heat, to the cylinder walls or elsewhere, would be above 1000 degrees, Fahr., and it would not make any difference whether the compression was done in two seconds or in two weeks. If our inquirer has made a compressor which delivers air in appreciable volume continuously at the high pressures mentioned without manifesting the customary high temperature he, of course, knows what he is talking about, and the wonder should be exhibited.

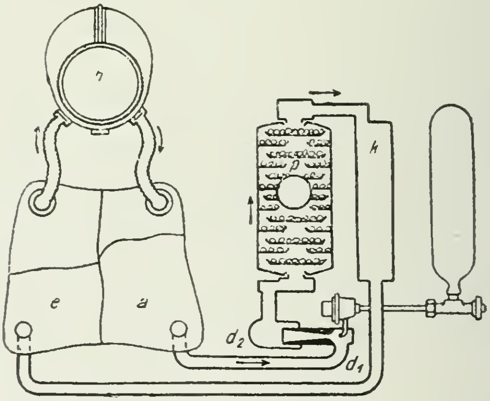


FIG. 1.

IMPROVEMENTS IN OXYGEN APPARATUS

BY BERGASSESSOR GRAHN

With a view to removing all possible objection to the use of injectors in rescue apparatus on the score of penetration by poisonous gases in consequence of the negative pressure in such

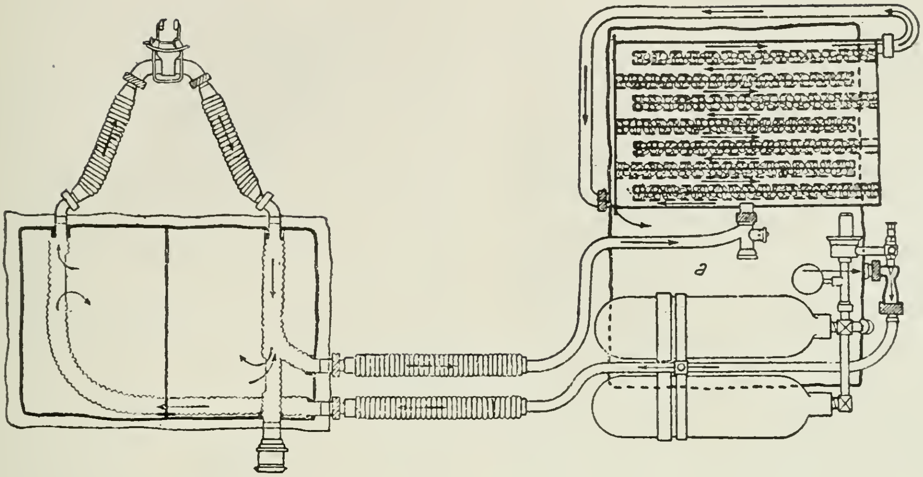


FIG. 2.

apparatus, the German makers have adopted means for ensuring the prevalence of positive pressure in same. Fig. 1 is a diagrammatic representation of the 1913 pattern of the Draeger apparatus, showing the course traversed by the contained air. The exhaled air is drawn out of the bag *a* by the injector, and passes the suction nozzle d_1 and the delivery nozzle d_2 into the regenerator or cartridges *p* from below, issuing from the top of same, then flowing through the cooler *k* into the breathing bag *e*, and thence into the helmet *h* or mouthpiece. In contrast to the earlier patterns, therefore, the air is forced through the cartridges instead of being drawn through them.

The idea on which the modified arrangement was based was that the lowest pressure must necessarily obtain on the suction side of the injector, and that consequently, to prevent negative pressure, the air to be breathed ought to be drawn from a large receptacle instead of the narrow cartridge with its relatively high resistance.

For similar reasons the makers of the Westfalia apparatus included in their latest, or 1912, pattern (fig. 2), an injector bag *a*, situated between the regenerator and the injector, so that the latter can draw the air as directly from the bag as possible. The new bag is provided with a number of weak internal rubber bands, which tend to contract the bag as soon as the positive pressure sinks, as the result of an increased need of breathing. Both forms of apparatus must be filled with air before use, either by the wearer inhaling the outer air for several breaths and exhaling into the apparatus, or else by starting the injector for a few minutes before-

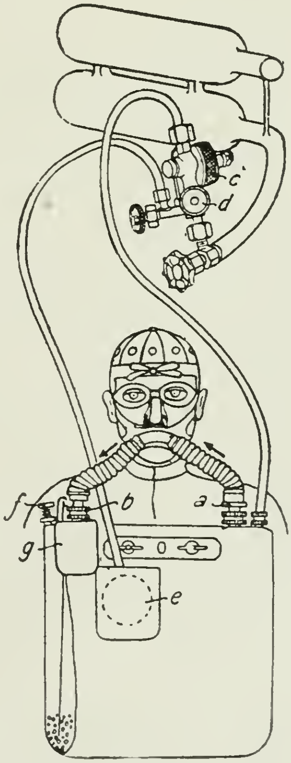


FIG. 3.

hand. The loading of the blow-off valves is increased to 80 to 90 millimetres water-gauge in the Draeger apparatus and to 140 to 150 millimetres in the Westfalia apparatus.

A number of experiments were carried out to determine the amount of positive pressure obtaining in these new patterns while in use, with the result that in place of the negative pressure of 2 to 3 centimetres (Draeger) and 4 to 5 centimetres (Westfalia), there was found a positive pressure of 0 to 6 centimetre (Draeger), and 0 to 12 centimetres (Westfalia), thus demonstrating the possibility of constructing injector apparatus free from negative pressure.

From the results of the measurements taken during the performance of manual labor while wearing the apparatus, it seems advisable not to begin heavy work too soon at the start, or the regenerators may become prematurely exhausted. The better plan is to work moderately and breathe quietly at first, in order that the regenerative material may warm up gradually, since it works better and remains active longer under these conditions. With both the old and new patterns of apparatus work may be performed to the extent of 50,000 kilogrammetres in two hours. For such large amounts of work, however, it would be desirable to increase the size of the regenerators in the Westfalia apparatus, the present size being nearly exhausted at 40,000 kilogrammetres.

Similar experience was obtained in working with the Fleuss apparatus (fig. 3), which is of the non-injecting type recommended by Prof. Cadman. The air is drawn through the caustic soda in the regenerator by the power of the lungs, through flexible tubes attached to the two halves of the bag, and provided with inhaling and exhaling valves *a* and *b*. The oxygen from the two bottles on the back escapes through a reducing valve *c*, at the rate of about 90 cubic inches per minute, into the inhaling half of the bag. In case of need, the wearer can increase the oxygen supply by opening a by-pass valve *d*. Should the bag become overfilled with air or oxygen, the pressure can be relieved by pressing on the valve *l*.

Whereas, in the Draeger and Westfalia apparatus, the air is compelled to pass through the various layers of absorbent material in succession, it follows its own devices in traversing the regenerative material of the Fleuss apparatus; and it is, therefore, not surprising that the purification of the air should be more uniform and complete in the former. This was demonstrated in a working experiment with skilled operators doing work to the extent of 25,000 kilogrammetres in an hour. Whilst in the two former apparatus the air at the end of that period contained only 0.04 per cent. of CO_2, the percentage in the Fleuss apparatus was already 1.86 per cent. Moreover, since the frictional resistance of the air in the apparatus has to be overcome by the lungs alone, the wearer has to be well trained in its use before any large amount of work can be performed.

SAFETY OF PNEUMATIC TIRES IN HOT WEATHER

A practical test has been made by the Goodyear Tire & Rubber Company, Akron, Ohio, to convince car owners of the facts and induce them to preserve their tires instead of injuring them by under-inflation in hot weather.

The test was made June 24, the hottest June day ever recorded in Akron. A runabout was chosen—one that was too heavy for the tires with which it was equipped. The tires were all pumped to 80 pounds, in the cool of the garage. After some intermittent driving, the car was run at high speed continuously half an hour, over hot brick pavement and wood block covered with hot tar. The test concluded with a little spin at 40 miles an hour over hot brick pavement. The air pressure was measured shortly after and it had increased an average of exactly four pounds.

This increase made no difference at all, so far as the welfare of the tire was concerned. In testing, tires are frequently inflated to 300 pounds and over, the rim always giving way before the tire sustains any damage.

Some car users have been in the habit of using their tires under-inflated in hot weather, on the theory that the heat of the sun and hot roads would expand the air, increase the pressure, and burst the tires. There is no ground for this fear and the man who under-inflates in hot weather only injures his tires. It is realized that some car owners will insist on using their tires at less than recommended air pressures for the sake of greater comfort, but the result inevitably is shorter tire life.

WATER PIPE COLLAPSED BY VACUUM

A curious accident happened to the discharge pipe of a pump located in a large, deep well to remove the surface water while digging. From the pump to the top of the well. standard iron pipe was used, and from the well to a lake, a distance of 300 ft., at a slight elevation, 6-in. galvanized sheet-iron pipe of No. 20 gage was used. All went well for several days until it was necessary to stop the pump on account of trouble in the water end. No provision was made for gradually draining the pipe, so that when the pump head was removed the rush of water down the pipe formed a partial vacuum in the line. which caused about 50 ft. of the sheet-iron pipe to collapse, so that it had the appearance of having been run between a pair of rolls. A wooden trough was substituted and further trouble was obviated.—*Power.*

A TOO SUCCESSFUL AIR FILTER

A Crowell rotary belt-driven air compressor, giving about 150 to 200 cu.ft. of air per minute, at 15 lb., had done good service for over a year, when suddenly it began to fall off, both in the quantity and the pressure of the air. The chief mechanic did all that seemed possible to repair it. cleaning the relief valve, etc., but in vain; it would not compress.

Finally, the brilliant idea occurred to us that since there was an outlet for the air there ought to be an inlet. The inlet was covered with fine wire gauze, about 70-mesh, to keep out anything that might be detrimental to the compressor. (This happened at a woolen mill, where the air may be more or less filled with all sorts of flocks and lint.) We found the gauze completely covered with a peculiar mixture of fine lint, dust and grease, which acted practically as though the screen were varnished. When the screen was cleaned the air compressor did its work as intended —*Power.*

IRRIGATION TUNNEL IN INDIA

An irrigation canal to water a maximum of 448,895 acres of land has recently been completed in the Punjab district of northwest India, at a cost of $6,390,000. It has a length of 150 miles, of which 11,235 ft. was a tunnel through the Malakand hills. The aqueduct traverses wild and rocky country, and 167 gulches from 20 to 100 ft. deep are crossed The tunnel is the second longest in India, has a cross-section of 13½ by 18 ft., and has a capacity of 2420 cu. ft. of water per second. The grade is 1 in 215. Rock cut was a tough and hard muscovite granite, which quickly blunted the best steel. Three shafts were sunk for ventilation, unwatering, discharge of rock, and opening more faces to work at. An average of 400 drills per day were sharpened. In each heading 16 holes were drilled, also 14 in the sides and bottom. These were from 5½ to 7 ft. deep, and it took from 10 to 16 hours to drill a round of 30 holes. Blasting and removing rock occupied from 5 to 8 hours. An advance of 4 to 6 ft. was made each blast. Nobel's blasting gelatine and Monobel were used. The cost was 24c. per cubic foot of rock removed.

NOTES

A clean, sharp, thoroughly dried silica sand or crushed quartz should be used for sand-blasting, and for use with a ¼-in. nozzle the sand should be screened through a No. 8 screen, and through a No. 12 when a ⅛-in. nozzle is used.

A steel tower 1092 ft. high, or 100 ft. higher than the Eiffel tower, has recently been started at Laeken, near Brussels. The first rivet was driven in the presence of the International Wireless Telegraphy Commission. It is to be used for investigations in meteorology and wireless telegraphy.

Careful measurements were made during the past year by means of which it was determined that the soot fall in Pittsburg ranges from 595 to 1950 tons per square mile per year. London has been considered one of the "gloomiest" cities in the world, yet the soot fall in London is only 426 tons per square mile per year.

Just one hundred years after George Stephenson made a trial trip with his first locomotive at Killingworth colliery, the new "centipede" locomotive of the Erie Railroad. of what may be called the Mallet-and-a-half type, hauled out of Binghampton, N. Y., a coal train much longer and heavier than any previously on record. The train consisted of

250 loaded cars, was about 2 miles long and weighed 21,000 tons.

It is usually supposed that at great heights the pressure of the air is almost negligible, but the application of an ingenious method indicated by Ramsay gives interesting results. He asserts that the green line characteristic of the spectrum of krypton remains visible under a pressure of 0.000035 millimeters of mercury. Now this green line is found in the spectra of the aurora borealis and it seems to be well established that this exists frequently at altitudes between 100 and 200 miles, and even sometimes up to nearly 500 miles. But krypton is one of the heaviest gases in our atmosphere and whatever the cause of the presence of krypton there, it could not remain there unless the air possessed an appreciable density.

Though its use is still subject to litigation, water has been turned into the Laramie-Poudre tunnel, the 2-mile bore through the backbone of the Colorado Rockies, irrigating the lands of the Greeley-Poudre irrigation district on the eastern slope. The tunnel takes water from the Laramie River, on the western slope, into the Cache La Poudre and through canals to the lands to be cultivated.

When the term "brass" is used by itself, everyone understands that an alloy of copper and zinc is intended. Similarly "bronze" always represents an alloy of copper and tin Yet a copper-zinc alloy containing a very small percentage of manganese—and therefore properly speaking a "brass"—is known as manganese bronze. German silver, again, is entirely innocent of silver, being an alloy of copper, zinc, and nickel.

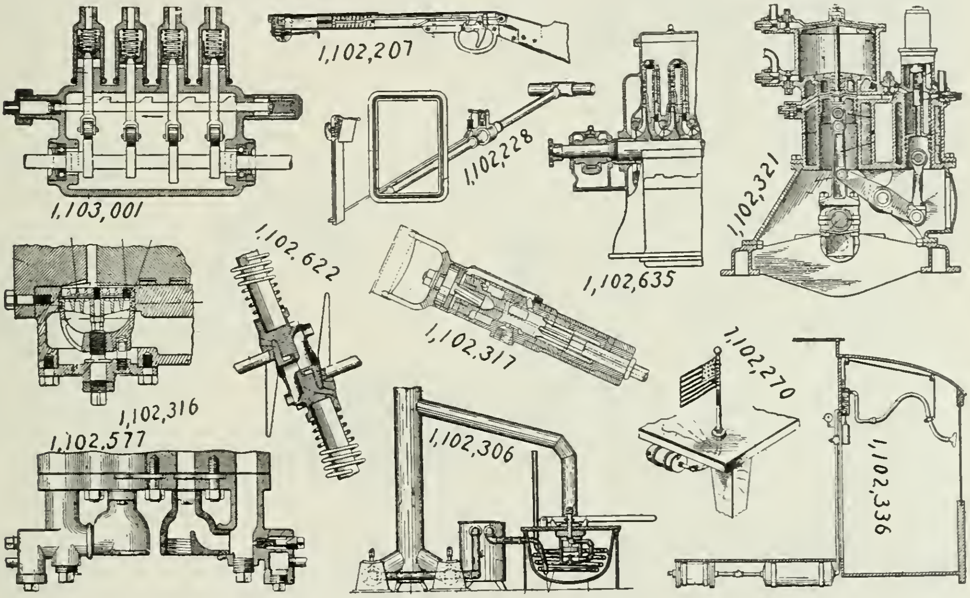
There was recently tested satisfactorily at the Standard Oil Works in Bayonne, New Jersey, a device for automatic extinguishing of fire. The tank of 50,000 gallons capacity was nearly filled with water, on the surface of which was a layer of Mexican crude oil five inches deep. Above this two buckets of gasoline were suspended to assist ignition. From the time the oil was fully ablaze until the time of extinction of the fire, was only nine seconds. The principle consists in producing large volumes of carbon dioxide by the automatic mixing of the proper ingredients, which are contained in four upright tubes attached to the tank. The contents of the tubes are held in position by fusible wires, which, when the temperature reaches a certain point are fused, permitting the constituent substances in the tubes to mingle and produce large volumes of the carbon dioxide.—*Scientific American.*

The balance-wheel of an average watch makes 300 vibrations every minute, 18,000 each hour, 432,000 in a day, or 157,788,000 per year. At each vibration of the balance-wheel it makes about one and one-half revolutions, and it is thus seen that the arbor or shaft on which the balance-wheel is mounted makes about 236,682,000 revolutions in its bearings in one year. One drop of oil is sufficient to lubricate from one to two hundred of such bearings. A modern locomotive with 7ft. drivers would have to run 985,824 miles, or more than thirty-nine times around the earth, which, at the rate of one mile per minute, without stopping, it would take 683 days, or nearly two years to do, before the axle of the driver would make as many revolutions as the balance staff of a watch makes in one year.

In the course of a paper by Mr. A. D. Mitton, read recently before the Manchester Geological and Mining Society, the author said that many mines were using electric lamps entirely, except for examination of the mine for gas. In a recent case where only electric lamps were used a man was overcome by gas, and died before its presence had been detected. The management at once ordered that in every working place where electric lamps were used there must always be a spare flame lamp; but a few days afterwards a heavy blower of gas came out suddenly whilst work was in progress; the gas immediately extinguished the flame lamp, and the men just managed to escape with their lives, thanks to the electric lights which showed them the way.

Why popcorn pops is not fully understood, says a recent bulletin of the Agricultural Department. Formerly it was supposed that the popping resulted from the expansion of oil in the kernel on being heated, but more probably it is due to the expansion of moisture contained in the starch cells. This moisture expands, when heated, with sufficient force to cause an explosion of the cells and the kernel turns completely inside out, enveloping the embryo and hull. Probably the expansion of the air within the seed coat also plays some part in the process.

According to the researches of Messrs. Trillat and Fouassier, published by the Académie des Sciences, microbes suspended in the air act as centers of condensation, when the air is humid. The authors give evidence of the existence of microbian drops in the atmosphere and they have studied their properties. One very interesting result is that the sudden cooling of the atmosphere has the effect of transporting the microbes and localizing them in determinate regions. The cool surfaces attract them from a distance almost instantaneously, the smaller being transported farther. These new ideas throw light upon the genesis of certain epidemics, and may be useful in planning the distribution of inhabited places.—*Scientific American.*



Pneumatic Patents July 7.

A coal bed in Colorado has been burning for nearly a hundred years. In some of the Welsh coal mines there are fires that have been alive quite as long. Near Summit Hill, Penn., a fire has been burning in a body of anthracite for fifty-three years. It is still unquenched. Already it has destroyed coal to the value of $26,000,000. Almost as many millions have vanished in the same way in a fire in an Ohio coal bed that has lasted twenty-eight years. Near New Castle, Colo., the first white settlers observed smoke rising from a mountain plateau. At first they thought it came from an Indian encampment. But it continued week after week. Investigation proved that a seam of coal was burning. From the Indian traditions it appeared that this fire had been burning more than a century.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 7.

1,102,228. APPARATUS FOR LOCALIZING THE EFFECT OF MINE EXPLOSIONS. JOHN FORDYCE BALFOUR, Edinburgh, Scotland.

1. Apparatus for localizing the effects of explosions in mines, comprising a primary operating device mounted in a locality where explosions are liable to occur and adapted to be set in motion by a sudden change of air-pressure, a system of water discharge pipes surrounding a section of a gallery situated at a distance from the primary apparatus and provided with narrow water-outlets directed toward the center of the gallery, a water-supply pipe communicating with the said water discharge-pipes, a valve interposed between the said water supply-pipe and water-discharge-pipes, and means adapted to operate the said valve under the influence of the said primary device, substantially as described.

1,102,270. PNEUMATICALLY-OPERATED DISPLAY DEVICE. Charles Lowell Howard, Washington, D. C.

1,102,271. PNEUMATIC TOOL. Harry S. Hunter, Pittsburgh, Pa.

1,102,306. APPARATUS FOR TREATING BARRELS. Harry Torchiani, Chicago, Ill.

1,102,316. VALVE FOR COMPRESSORS. Lewis C. Bayles, Easton, Pa.

1,102,317. VALVELESS PERCUSSIVE TOOL. Lewis Condict Bayles, Easton, Pa.

1,102,321. AIR-COMPRESSOR SYSTEM FOR OIL-ENGINES. Jules Cochaud, Zurich, Switzerland.

1,102,323. PNEUMATIC-DESPATCH SYSTEM. Roderick G. Collins, Jr., New York, N. Y.

1,102,324. TERMINAL FOR PNEUMATIC-DESPATCH APPARATUS. Roderick G. Collins, Jr., New York, N. Y.

1,102,336. FROST-REMOVER. Joseph J. Heim and William Nottberg, Kansas City, Mo.

1,102,577. TRACK-SANDING DEVICE. John Gapp, Scranton, Pa.

1,102,622. FLUID-PRESSURE COUPLING FOR TRAIN-PIPES. Leonidas D. Woodruff, Hattiesburg, Miss.

1,102,635. TURBO-COMPRESSOR. Otto Banner, Easton, Pa.

1,102,807. FILM-BURSTER. Charles P. Shaw, Detroit, Mich.

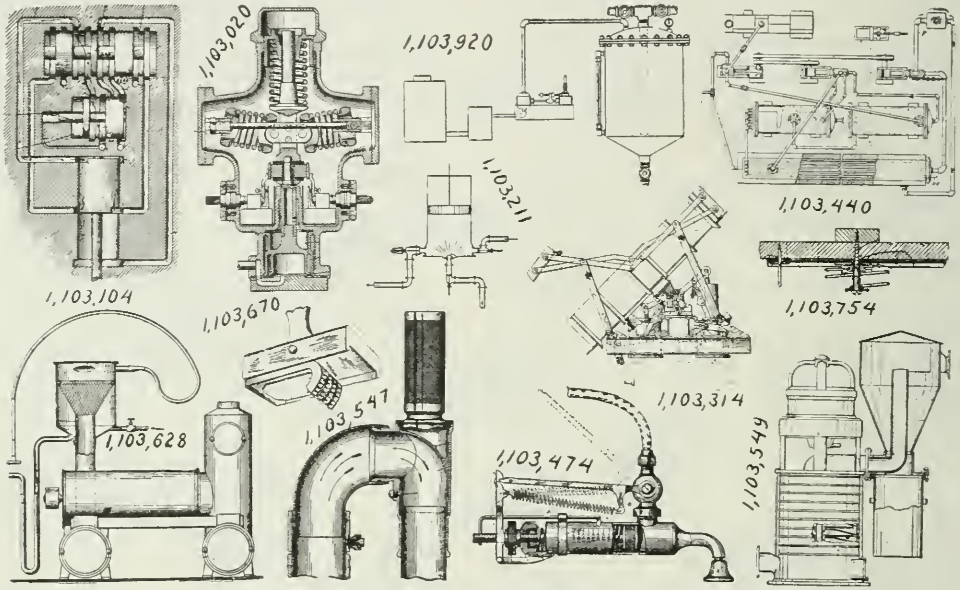
1. In a pop-gun, the combination of a barrel provided with a lateral hole near its outer end, a plug fixed in the outer end, means for forcing the air out through said lateral hole, and means for clamping paper about said lateral hole substantially as described.

1,103,001. DISTRIBUTING DEVICE FOR AUTOMATIC COMPRESSED-AIR STARTING APPARATUS FOR INTERNAL-COMBUSTION ENGINES. Marcel Gendron, Paris, France.

JULY 14.

1,103,020. FLUID-PRESSURE-REGULATING MECHANISM. Walter M. Austin, Swissvale, Pa.

1,103,084. AUTOMATIC AIR-CUSHION AND SHOCK ABSORBER. Mathew Varner Ruff, Smyrna, Ga.



Pneumatic Patents July 14.

1,103,104. FLUID-PRESSURE ENGINE. Paul G. Tismer, New York, N. Y.

1,103,211. PROCESS OF PROTECTING PUMPS FROM OZONE. Christoph Knips, Charlottenburg, Germany.

1,103,213. EXPRESSION DEVICE FOR PNEUMATICALLY - OPERATED MUSICAL INSTRUMENTS. Richard A. Leadbeter, Detroit, Mich.

1,103,237. BLOWER FOR ROTARY MILLS. Milton F. Williams, St. Louis, Mo.

1,103,314. DUMP-CAR. Jay B. Rhodes, Kalamazoo, Mich.

1,103,440. PROCESS AND SYSTEM FOR PRODUCING POWER. Charles A. Sellon, Alliance, Ohio.

1. The process of producing and utilizing power which consists in raising the temperature of air by compressing it, then passing the hot compressed air through water to raise the temperature of the latter, then causing the air to expand and utilizing the lowered temperature thereby produced for refrigerating purposes, and returning the expanded air to the point of compression and at the same time preheating the expanded air by heat transference from the compressed air.

1,103,474. PRESSURE-REGULATING DEVICE. Henry R. Bickford, Monterey, Cal.

1,103,535. APPARATUS FOR BURNING LIQUID FUEL. William E. Oakley, Astoria, N. Y.

1,103,547. VALVE FOR CLEANING-TOOLS. Ira H. Spencer, Hartford, Conn.

1,103,548. CLEANING APPARATUS. Ira H Spencer, Hartford, Conn.

1,103,549. DUST-SEPARATOR. Ira H. Spencer, West Hartford, Conn.

1,103,628. CLEANING APPARATUS. Ira H. Spencer, West Hartford, Conn.

1,103,670. AIR - CUSHION FOR RUBBER STAMPS. Calder C. Gibson, Buffalo, N. Y.

1,103,684. ATOMIZER. Elihu R. Pettit, Philadelphia, Pa.

1,103,754. AIR-VALVE. Robert A. Gally, Cincinnati, Ohio.

1,103,790. EMERGENCY AIR-BRAKE DEVICE Joseph H. Macleary, Wilmington, Del.

1,103,920. METHOD OF STORING UNFERMENTED FRUIT-JUICE. Francis J. Walker, Jr., Erie, Pa.

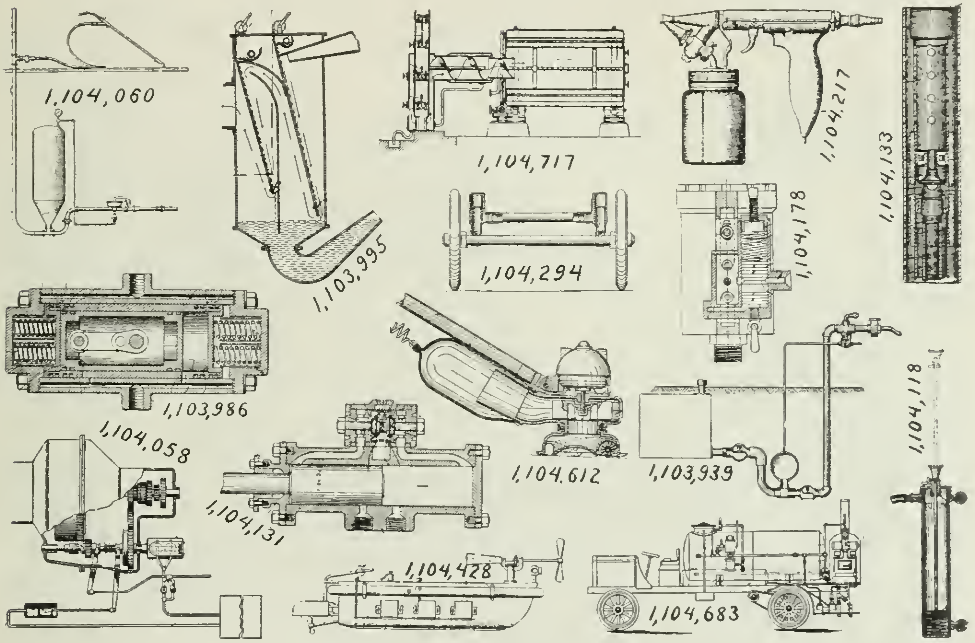
1. The method of storing unfermented fruit juice, consisting in placing sterilized juice in an inclosed tank, and connecting said tank with a source of sterile air, under uniform pressure adapted to supply leakage of air therefrom, substantially as set forth.

JULY 21.

1,103,939. FLUID-DISPENSING APPARATUS. John James Catron, Bonham, Tex.

1,103,986. COMPRESSOR-PUMP. Thomas E. Murray and August W. H. Griepe, New York, N. Y.

1,103,995. APPARATUS FOR TRAPPING PARTICLES IN SUSPENSION IN GAS-CURRENTS. Thomas E. Murray, New York, N. Y.



Pneumatic Patents July 21.

1,104,011. METHOD OF TREATING OLD WELLS. Walter O. Snelling, Pittsburgh, Pa.

1. The method of treating old wells, which consists in closing the well and producing therein, in a slow and regular manner, a large volume of highly heated gas under considerable pressure, in such a manner that the gas so produced will, in passing outward from the well, tend to melt, dissolve, thermolize, decompose or otherwise remove paraffin and other bodies obstructing the pores or passages of the formation adjacent to the well.

1,104,058. STARTING DEVICE FOR EXPLOSIVE-ENGINES. Walter L. Marr, Flint, Mich.

1. The combination of an engine, a fly wheel therefor, and a change speed mechanism one of whose members always moves with the engine, with an air pressure tank, a combined compressor and motor whose cylinders are in communication with the tank, means controlled by the compressed air in the tank and adapted to operatively connect the compressor with the change speed mechanism for forcing air into the tank, manually operable means for connecting the compressor to rotate the fly wheel and to admit air to the compressor as a motor from the tank, adapted to automatically release the fly wheel from the compressor when the speed of the fly wheel exceeds the speed of the compressor.

1,104,060. VACUUM CLEANING APPARATUS. Frank J. Matchette, Milwaukee, Wis.

1,104,131. FLUID-MOVED VALVE. George S. Power, Nutley, N. J.

1,104,133. APPARATUS FOR FORCING FLUIDS FROM WELLS. William P. Randall, Le Roy, N. Y.

1. In an apparatus of the character described, the combination with a fluid pressure chamber and an ejection tube movable longitudinally therein, the lower portions of said chamber and tube being adapted to be submerged, of a valve normally closing the ejection tube against the entrance of fluid arranged to be opened by the movement of said tube and to admit fluid thereinto, said tube being provided with perforations for the inlet of gas from the surrounding chamber and means for introducing fluid under pressure into said chamber.

1,104,118. SHUTTER-OPERATING DEVICE. Joachim T. Holtfoth, Kalamazoo, Mich.

1,104,178. FLUID - PRESSURE - OPERATED LUBRICANT-CUP. Frank Fleming, Sacramento, Cal.

1,104,217. PNEUMATIC PAINT-BRUSH. Jens A. Paasche, Chicago, Ill.

1,104,228. REGULATOR FOR PNEUMATIC SERVICE SYSTEMS. Joseph J. Stoetzel, Chicago, Ill.

1,104,294. PNEUMATIC SUSPENSION FOR VEHICLES. Charles A. Erickson, Plattsburg, N. Y.

1,104,428. LIFE-BOAT. John Kertesz, Pottstown, Pa.

1. The combination with a life boat, of a pneumatic tube arranged around the exterior of the boat, an air storage tank, a wind-driven pump for supplying air to said tank, and a connection between said tank and tube.

1,104,612-3. SUCTION-CLEANER. Edward J. Bodey, Cincinnati, Ohio.

1,104,633. SPRAYING APPARATUS. Walter Cressy, Gloucester, Mass.

1,104,693. AUTOMATIC AIR-BRAKE SYSTEM. William Miller, Gilman, Mont.

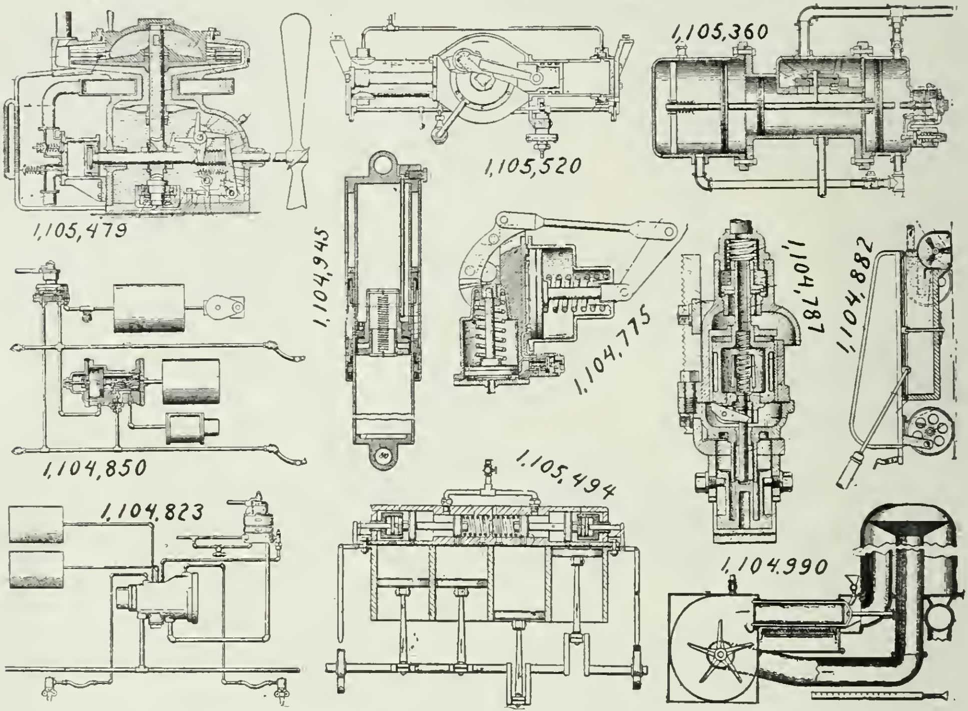
1,104,717. APPARATUS FOR PRODUCING AND CONTROLLING MOISTENED AIR IN MALTING-DRUMS. Ludwig Topf, Erfurt, Germany.

JULY 28.

1,104,775. FLUID-PRESSURE BRAKE. Francis L. Clark, Pittsburgh, Pa.

1,104,787. AUTOMATIC TRAIN-STOP DEVICE. Alexander England, Wilkinsburg, Pa.

1,104,823. AUTOMATIC TRAIN-BRAKE-CONTROL APPARATUS. Howard M. P. Murphy, Pittsburgh, Pa.



Pneumatic Patents July 28.

1,104,850. HIGH-PRESSURE EMERGENCY-BRAKE. Walter V. Turner, Edgewood, Pa.

1,104,882. PNEUMATIC CLEANER. Leonard L. Ferguson, Chicago, Ill.

1,104,945. FLUID-PRESSURE DEVICE. George Westinghouse, Pittsburgh, Pa.

1. An elastic compression device, comprising relatively movable members for varying the volume of the elastic fluid contained in said device, in combination with a pump having a cylinder mechanically connected with one of said movable members and a piston mechanically connected with the other of said members and arranged to increase the pressure on the low pressure side of the sliding joint between said members.

1,104,959. VACUUM LIGHTNING-ARRESTER. Frank Spencer Chapman, Toledo, Ohio.

1,104,976-7. PNEUMATIC CARPET CLEANER. Leonard L. Ferguson, Chicago, Ill.

1,104,990. PROCESS FOR POPPING CORN. Charles Knox Harding, Chicago, Ill.

The process of popping corn, which consists in producing pressure within the kernels by the application of heat and exploding the kernels while maintaining a gaseous pressure on the exterior of the kernels less than normal atmospheric pressure.

1,105,352. PNEUMATIC PAPER-FEED MECHANISM. Otto Kirsch, New York, N. Y.

1,105,360. TRIPLE VALVE. Howard Otis Martin, Clovis, N. Mex.

1,105,479. COMPRESSOR. Emil Anderson, New York, N. Y.

1,105,494. COMBINED AIR COMPRESSOR AND MOTOR. David E. Crouse and Charles G. Eidson, Annapolis, Md., and Thomas Davis, Wilkinsburg, Pa.

1,105,520. STARTER FOR INTERNAL-COMBUSTION ENGINES. Clarence L. Johnston, Oakland, Cal.

1. An engine starter including an air storage reservoir, an air actuated motor convertible from a motor to a compressor and vice versa, means for admitting air from the air storage reservoir to the motor for operating the same to start the engine, means for shutting off the flow of air thereto upon the starting of the engine to convert the motor into a compressor, a valve controlled air supply inlet to the motor, a valve controlled connection from the motor to the storage reservoir adapted for recharging the air storage reservoir when said motor is acting as a compressor, means for connecting the motor with the engine shaft upon the starting of the motor to start the engine, means connecting the motor and engine shaft and actuated upon the starting of the engine for operating the compressor and means for actuating the last mentioned means whereby said last mentioned means will be rendered inoperative on the air in the storage reservoir attaining a predetermined pressure.

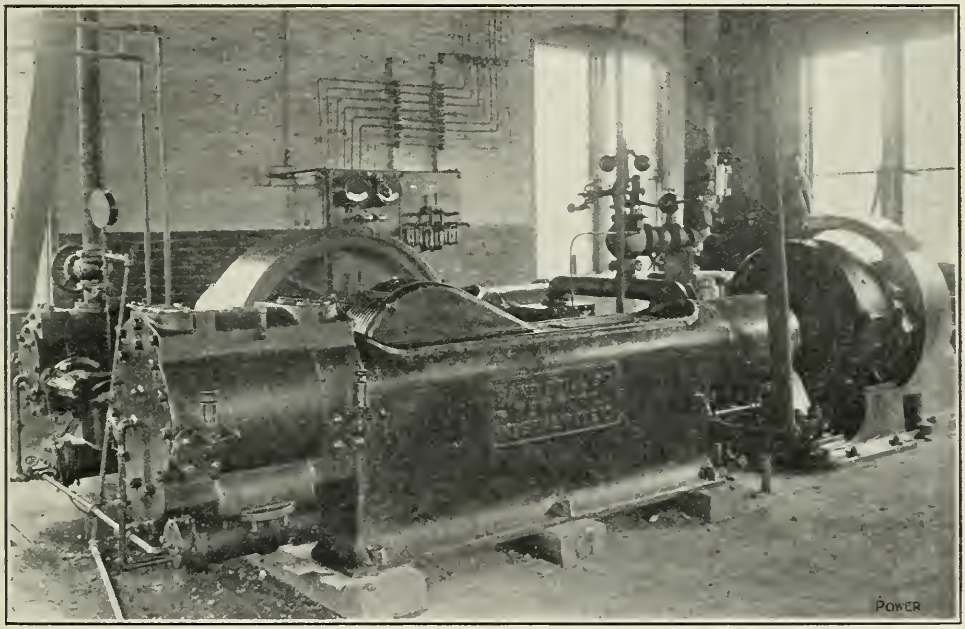
1,105,569. PNEUMATIC SUIT FOR AVIATORS. Nazaire Lacrotte, Paris, France.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

Vol XIX OCTOBER, 1914 No. 10



AIR COMPRESSOR WITH EXCELLENT RECORD.

A REMARKABLE AIR COMPRESSOR RECORD

BY FRANK RICHARDS

The half-tone on this page reproduces an excellent photo of an air compressor at the Hollenbeck Colliery of the Lehigh & Wilkes-barre Coal Company with a record worth noting. This, as will be seen, is an entirely self-contained machine with high pressure steam cylinders and two-stage air cylinders, the diameter of the former being 12 in. and the latter 18 in. and 11 in., with a common stroke of 16 in., the theoretical free air capacity at 150 r.p.m. being 704 cu. ft. per min. This compressor was shipped on June 27, 1905, and was immediately installed and put to work. Since then it has been operated continuously 24 hours per day, with the exception of a regular stoppage of two hours on Sundays for inspecting the discharge valves and a general cleaning up and looking over. For three or four years past the machine has been too small for the work and has been run at a speed from 170 to 225 r.p.m.—600 ft. piston speed. We have the word of the engineer of the power house that none of the cylinders have been rebored, that the compressor is still fitted with the same pistons and piston rings that it had when shipped from the factory. Discharge valves and discharge valve springs have been occasionally renewed, but some of them ran five or six years. There has never been any delay at this colliery that could be attributed to the compressor.

This machine has recently been replaced by a compressor of much larger capacity. When the change was to be made they picked it off its home foundations and placed it on the power house floor upon three 12 by 6 in. timbers as shown, without bolting down or fastening of any kind, made the pipe connections and started it up at once, and it is still running at its highest speed. The photo shows the compressor running, as is indicated by the disappearance of the fly wheel arms. The governor is evidently not running, as the chain which drives it is not in place. The sharpness of every detail in the photo shows the entire absence of jar or vibration.

The record of this machine is a record also for those who have had it in charge. It has had the best of care and systematic inspection. The oil, for instance, has been taken out of the crank cases and filtered every three weeks with such renewal as might be necessary. Beyond such care as this the engineers have had the happy faculty, sometimes painfully lacking, of letting well enough alone and giving things a fair chance. Records either good or bad could often have been reversed under different managements.—*Power.*

WHAT WAR DID FOR SUGAR

A hundred years ago in the days of the great Napoleon, sugar had already become more than a luxury and was much sought. As England controlled the seas and controlled also the sugar industry of the West Indies, Napoleon Bonaparte conceived the idea of developing the beet sugar industry so that France might be made independent of the rest of the world so far as its sugar supply was concerned. Our sugar books are full of the history of the gradual development of the beet sugar industry, the extraction of the beet juice by the old roller mills and later by hydraulic presses, and we might say only recently by diffusion, and this great industry producing now nearly half the sugar of the world, was the child of the Napoleonic wars that sprung direct from the brain of Napoleon Bonaparte when he was at the zenith of his powers.

A NEW DUST CATCHING LIQUID

In the F pit of the Washington Coal Co., southeast of Newcastle-on-Tyne, there was given recently a commercial scale trial of the new Belger colloid dust-laying process.

About 400 yd. of a main haulageway, along which pass 1,000 tons of coal a day, had been sprayed with the Belger fluid during the previous two months. The fluid, whose main components are glue and a 40 per cent. solution of calcium chloride, is sprayed from a 100-gal. tank, devised by A. Owen Jones.

This tank can come down the shaft in the cage and is then placed on wheels. The air used is at a pressure of about 2 atmospheres. It enters the tank by several small openings, so as to churn the fluid into foam, and a small jet of air is led into the outflow pipe to help the treacly liquid to become spray. The nozzles are of rubber, to enable solid particles to pass.

Humorists said the Belger process meant making the miners walk on flypaper, and any looker-on whose hand was accidentally sprayed found himself collecting every speck of dust which came near him for the rest of the day. But the track where the process has been used feels like a peaty path in dry weather, being slightly springy and not at all sticky.

Outside the sprayed area the track is several inches deep in fine dust. The sprayed roof and walls are sticky and look for a week or two as if whitewashed, then the gathering dust blackens them, but it does not appear that a fresh spraying will be needed for three months. The liquid is used warm, at 50 deg. C. to lessen its surface tension, but the spraying is not followed by evaporation, so no falls of roof result. Indeed, the liquid preserves rock from erosion and timber from decay, and does not, like water, encourage ankylostomiasis and other low forms of life.

The cost of using this spray in coal mines is about 50c. per yard per year.

Lately wood has been made fire proof by forcing into the same a solution of salt under high pressure, whereby its appearance and other properties were not changed. Such wool in contact with fire melts the impregnated salts and forms a crust, keeping the air off. By further increased heat the salt is decomposed, furnishing vapors which extinguish the flames

SAFETY AIR CUSHIONS FOR WOOLWORTH BUILDING ELEVATORS*

Recent tests of the automatic safety cushions in the bottoms of the shafts of the very high passenger elevators in the Woolworth Building, New York City, have demonstrated a high degree of efficiency in smoothly, quickly and safely stopping the cars when falling freely from their maximum height of about 600 ft. The application of the air-cushion system involved the construction of heavy airtight walls inclosing the bottom of the elevator shafts for several stories and capable of resisting a high, sudden internal pressure. There are also provided strong airtight entrance doors in different stories and special outlet valves to release the air and maintain the desired pressure under the piston action of the air. Inlet valves eliminate suction from ascending cars.

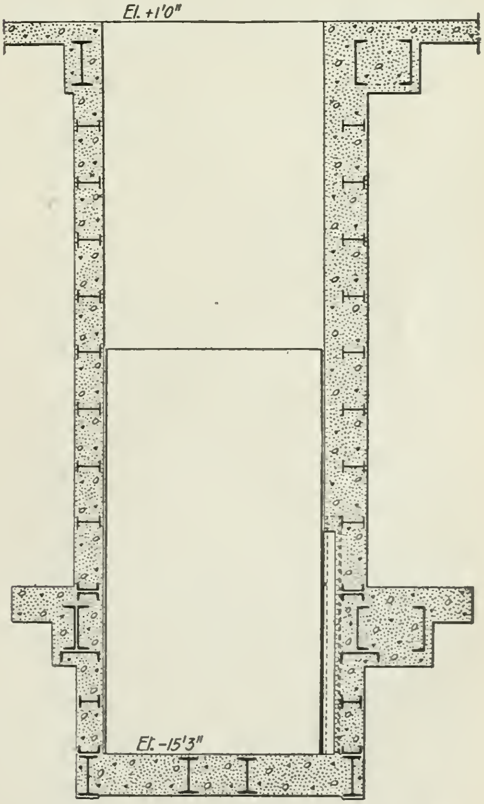
ELEVATOR EQUIPMENT.

The Woolworth Building has one of the largest and highest sets of passenger elevators ever installed. There are twenty-six electrically operated cars designed for a combined capacity of about 6000 passengers per hour in each direction carried at a speed of 600 ft. per minute for the low rises and 700 ft. per minute for the high rises. They are of the Otis standard gearless type, such as are used in the Metropolitan Life Insurance tower, Singer tower and other high buildings, and have cars of from 30 to 50 sq. ft. floor area which are provided with the usual safety appliances for stopping them in case of accident or excessive speed. Two cars travel 679 ft. from the first to the fifty-first story, two travel about 606 ft. from the first to tthe forty-sixth story, two travel 530½ ft. from the basement to the fortieth story, fourteen travel 358½ ft. from basement to the twenty-seventh story, two travel to the twenty-eighth story and four travel to the twelfth story.

AIR CUSHIONS.

To provide a safeguard against injury by too rapid descent each elevator has the lower portion of its shaft inclosed in air-tight steel and concrete walls, adapted to retain the air under the plunger action of the descending car and form an elastic cushion, bringing it gradually to rest. The cushion walls extend up to the fourth, fifth, seventh, eighth and eleventh stories, according to the height of the elevator shaft, and have a maximum effective height to 135 ft. 3½ in. The walls are of concrete reinforced with horizontal web I-beams, except in cases where the counterweight walls are too close to the car shaft to admit the concrete construction. Steel buckle plates are used to cover the counterweight shaft.

In all cases the faces of the walls are parallel, except at the bottom, where for a distance of about one story they are narrowed to fit the car quite closely. The webs of the I-beams on all four sides of the shaft are in the same horizontal plane and are cut to clear; they are spliced together at the corners by top and bottom web cover plates. They are connected to the structural columns by hitch angles and have grouting holes through the web. The lower 18 ft. of the walls are "cladded" with Portland cement and hardwood, the elevator platform with trimming pieces being used as a template allowing from ¼ in. to ½ in. clearance.



SHAFT TO RESIST CUSHION PRESSURE

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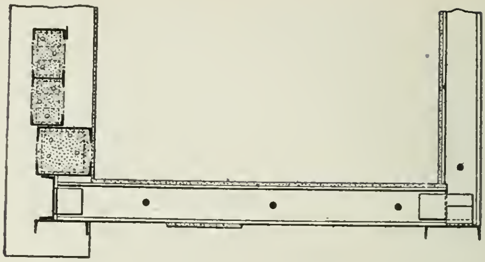
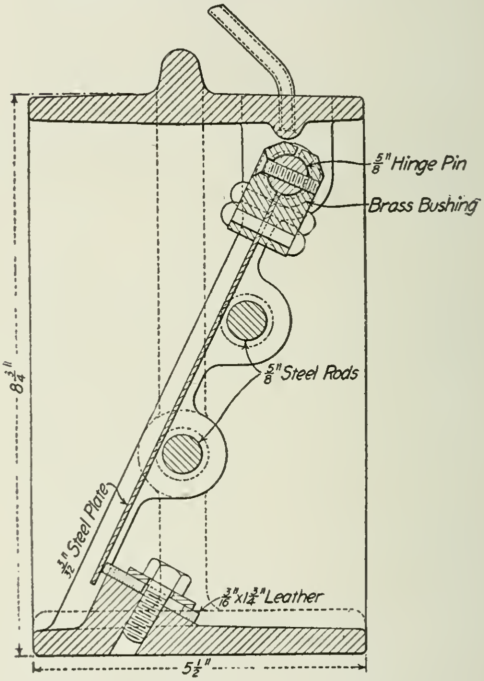
*Engineering Record, Sept. 5, 1914.

The calculated average pressure required was less than 15 lb., but it was assumed that in service an instantaneous pressure slightly exceeding 20 lb. per square inch might be developed in the air cushion, and the walls were proportioned to withstand a pressure of 15 lb. with a maximum fiber stress of 20,000 lb. per square inch, the possible theoretical excess of the pressure not being computed to exceed the elastic limit. Under test the actual maximum pressure at the bottom of the cushion was about 18 lb. To resist these pressures, the lower doors are made of flattened drawn-steel tubes having an elastic limit of 44,000 lb., with tongues at the bottom, which are held in steel sills firmly built into the floor concrete. The upper doors, which could be thicker than the lower ones on account of space conditions, are made of similar oval steel tubes plated back and front with Nairno ½-in. wire-glass panels in the center. The doors are operated by the Burdett-Rowntree compressed-air apparatus, by which they are automatically closed and maintained closed when not held open by the operator, a condition which is essential to the integrity of the system.

In the lowest 15 ft. of the air cushion the clearance between the car and the wall is one-thirty-fifth the area of the car; above that point it is one-fifteenth the area of the car. The natural efflux of air between the car and the sides of the shaft is therefore constant for nearly the full height of the cushion, and without regulation would result in an intensification of pressure at the bottom of the shaft and in violent changes of velocity. To regulate these conditions the air in the cushion is controlled by special outlet valves set in the walls at different heights and adjusted to open instantaneously under a pressure of 12 lb. per square inch, or slightly less than the calculated pressure to allow for their inertia. They are disposed vertically in the shafts, so that as the falling car passes it cuts off their areas consecutively. Thus the car itself reduces the area of efflux so as to render retardation theoretically nearly uniform. There are in all 126 outlet valves, each having an area of 0.4 sq. ft. As no standard valves could be obtained which were sufficiently free from inertia to be satisfactory for this purpose, special valves were designed by Thomas E. Brown to secure positive, accurate, and rapid action. They consist of sheets of 1/32-in. tempered spring steel about 5 in. wide. The upper edge is securely clamped to a hinged bar and the reinforced lower edge is normally confined between adjustable stops on both sides. Under the required pressure the deflection of the thin plate displaces the lower edge sufficiently to clear the stops, and the valve swings open.



SHAFT FRAMING FOR AIR CUSHION

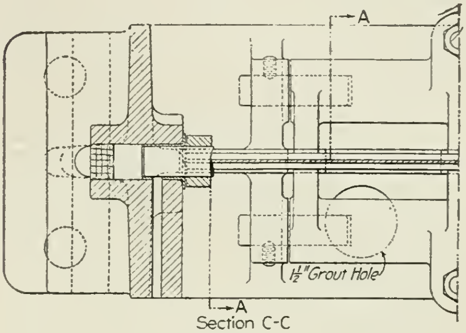


INLET VALVE FOR AIR CUSHION

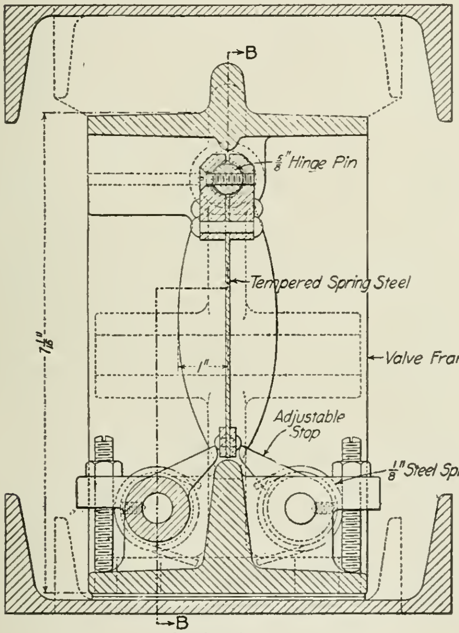
INLET VALVES

In order to prevent retardation of the cars in normal service when lifted out of the cushions seventy-two inlet valves about 12 in. long and 6 in. wide are set in the lower part of the walls. They are simple check valves made of inclined steel plates hinged on the upper edge and bearing on the lower edge against leather stops. They are opened by the exterior atmospheric pressure whenever there is any reduction in the air-cushion pressure, and when the latter is above normal they are held securely in place by coming into contact with horizontal supporting bars that prevent their deflection, but present little resistance to the inflow of air.

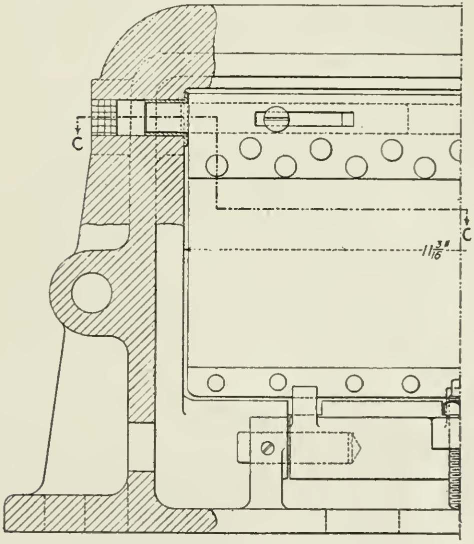
On the night of Oct. 16, 1913, one of the forty-six story cars, loaded to a total weight of 7500 lb., corresponding to a carful of passengers, was dropped freely from the forty-fifth floor and stopped safely by the action of the air cushion. It fell 470 ft. to the top of the air cushion in 5½ sec., and came to rest safely at the bottom of the air cushion in



Section C-C

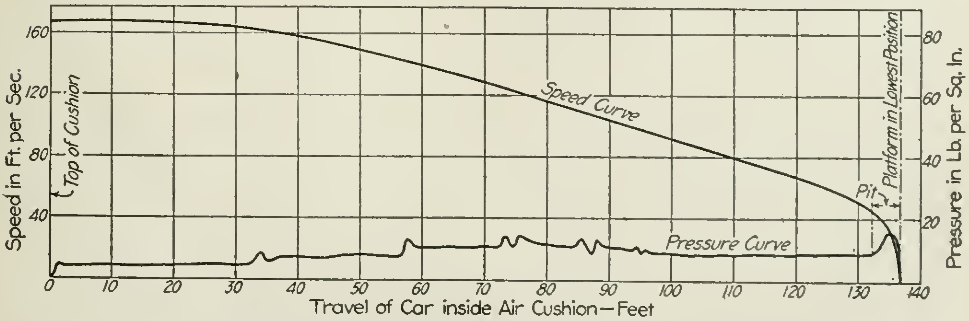


Section A-A



Section B-B

OUTLET VALVE FOR RELIEVING PRESSURE IN AIR CUSHION



DIAGRAMS OF VELOCITIES AND PRESSURES IN AIR CUSHION about 1½ sec. more. The cushion worked satisfactorily and the car doors and walls showed no indication of injury. The velocity in the cushion part of the shaft was reduced regularly and uniformly, and the pressure developed in the body of the cushion did not exceed 15 lb. per square inch, except at the last moment at the bottom of the pit, when it was increased to a maximum of 18 lb.

TESTING APPARATUS

The testing apparatus consisted of six specially designed steam-engine indicators with large drums equipped with electric magnets to hold the pencil points off the drums until the magnet current was broken. All the drums were rotated at constant speed by electric motors. Four indicators were connected with the shaft by pipes—one at the bottom and the three others at nearly equal intervals up to the fifth floor.

Two indicators were placed in the car. One was connected to the interior pressure by a pipe through the bottom of the car and the other to a water column carried in the car, consisting of a brass tube about 7 ft. high, to register the intensity of retardation. The motor revolving the drums of the two indicators in the car was equipped with a flywheel heavy enough to maintain constant speed during the short time of the fall, as current was cut off from this motor by the pulling out of a plug the instant the car left its starting point at the forty-fifth story. The magnet current of the fixed indicators was carried by a wire stretched across the top of the air-cushion shaft, which was broken by the car at the instant it entered the cushion.

The cushions and auxiliaries were designed by Thomas E. Brown, consulting engineer of the Otis Elevator Company, who planned and directed the test. Cass Gilbert was the architect of the building, and the Thompson-Starrett Company was the general contractor and installed the air cushions and valves.

AN AIR LIFT FOR AN EMERGENCY

BY M. J. MC GILL.

We hung 34 ft. of 6-in. pipe in the shaft from a point one set below the station and blanked the lower end except for a 1-in. drain with a gate valve. Within 4 in. of the end of some 2-in. pipe, we drilled several ¾-in. holes, and just above this tapped in a ¼-in. nipple with an ell on each end. In the outside nipple we screwed a ¼-in. pipe. The ¼-in. and the 2-in. pipes bound together, we lowered into the 6-in. pipe. The ¼-in. was connected to the compressed-air line, compressor pressure being 100 lb.; the 2-in. pipe was connected to an old 2-in. air line, which led to the winze. At about 100 ft. in we put in a tee on the 2-in. line and a valve to relieve the air pockets. The flow of water was directed into the 6-in. pipe. With the air-inlet valve open about one-sixth of a turn, the water kept about 14 in. below the top of the 6-in. pipe, except when the miners turned on the air to blow smoke from the shaft bottom.

POWER OF WINDMILLS

The following table, compiled by the Electric Review, shows the horse power which can theoretically be realized from a 28 ft. wheel exposed to winds of various velocities:

Speed of wind, m.p.h	H.P.	Speed of wind, m.p.h.	H.P.
2.25	0.04	22.5	40
6.7	1.1	33.5	135
11.2	5.0	45.0	520
15.7	13.0	67.0	1,080

The power available should increase with the cube of the wind velocity (since the kinetic energy of the air particles increases with the square of their velocity and the number of them striking the wheel blades per second increases in direct proportion to the wind velocity). It is not practicable to construct a mill which will use with equal efficiency a light breeze and a strong wind, hence the curvature and setting of the blades should be such that the mill works most efficiently when exposed to a wind of the velocity generally prevailing in the district. Breezes of eight to 15 m.p.h. are much more common than 20 m.p.h., hence it is generally advisable to employ a very light wheel which will start work in a 3.5 m.p.h. wind, and which can still be used when the wind rises to 10 m.p.h. Such a wheel could not be exposed fully to a 30 m.p.h. wind, and for safety a device should be mounted on the main wheel so that when the wind pressure exceeds a certain limit the inclination of the blades is changed, against the control of a spring, in such a manner as to reduce the effective area exposed to the wind. The control springs may conveniently be set so that they come into operation when the wind velocity exceeds 16 m.p.h., and so that the output of the mill is constant in winds above 18 m.p.h; there is thus secured maximum total annual output.

ENERGY OF A HAMMER DRILL BLOW*

The Paynter rock drill tester, a remarkably ingenious and useful machine, by means of which a graphic record of a drill's hitting ability is obtained, has been developed and put into service at North Star Mine, Grass Valley, California. The machine registers the intensity of the blow of the drill and makes it possible to count the strokes. Some interesting conclusions have resulted from a series of experiments conducted with this machine.

To express the energy of the blow in foot-pounds, the tester was calibrated by allowing a sphere of known weight, suspended as a pendulum, to fall through measured distances against the plunger of the tester. The corresponding distentions of the diaphragm, which controls the movements of the recording pencil, were noted. By forcing oil into the system with a pump, the diaphragm was distended to each of these points in turn, and the static pressure corresponding to each was read on the gage. A curve was then constructed with foot-pounds as abscissas and pounds of static pressure as ordinates. The strength of any blow, recorded on the graph, can be measured by pumping oil into the system until the distention of the diaphragm moves the recording pencil out the corresponding distance. The pressure in the system at this point is read on the gage. The foot-pounds corresponding to this can then be taken directly from the curve. Since the areas of the plunger and of the diaphragm do not change, equal blows will produce the same pressure, even though permanent straining of the diaphragm may result in their producing unequal distentions. Errors which might be caused by these inequalities of distention are avoided by thus expressing strength of blow in terms of equivalent static pressure instead of magnitude of distention.

From the graphs taken by testing a drill at different gage pressures, characteristic curves may be constructed, as shown in Figs. 1 and 2. There are also given the results of tests made to determine, if possible, the relations existing between drilling speed, blows per minute and foot-pounds per blow.

Table I compares: *a,* Three drills striking a hard blow; *b,* two drills striking a medium blow. These were tested in extremely hard ground with holes at an inclination of 25°, 1¼-in. cross steel with 2¼- and 2-in. bits being used; conditions, however, were kept the same for each test, which lasted 5 min.

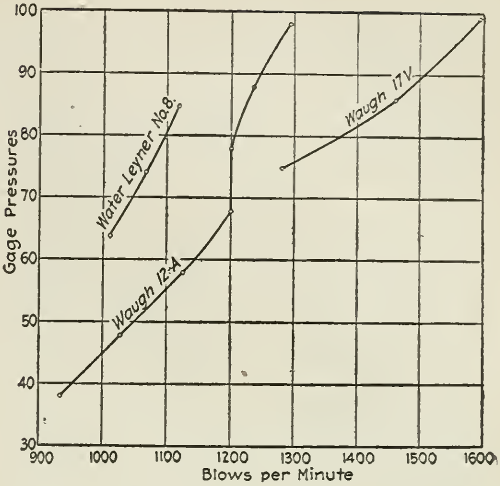


FIG. I. CHARACTERISTIC CURVES OF TYPICAL MACHINES SHOWING INFLUENCE OF GAGE PRESSURE ON BLOWS PER MINUTE.

TABLE I—COMPARISON OF DRILLING SPEEDS.

	Foot-Pounds.	Blows per Minute.	Drilling Speed. Feet per Minute.
a	52	936	0.126
	52	1320	0.165
	55	1584	0.250
b	40	1260	0.108
	42	2352	0.195

These results indicate that drilling speed varies approximately with the blows per minute, the strength of the blow remaining constant.

Table II compares drilling speed with varying strengths of blow. The conditions of test were: Ground only medium hard; length of each test 5 min.; 1¼-in. cross steel with 2-in. bit; holes at an inclination of 45°; drill, air-feed stoper.

TABLE II—CHANGES IN STRENGTH OF BLOW.

Blows per Minute.	Foot-Pounds per Blow.	Feet Drilled per Minute.
1272	48½	0.378
1222	43	0.447
1200	38½	0.308
1170	34½	0.250
1090	30½	0.188

A test under the same conditions as that of

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*From a paper by Robert H. Bedford and William Hague, Salt Lake Meeting of the A. I. M. E.

Table II, except that the inclination of the holes was 20°, gave the results shown in Table III.

TABLE III—RESULTS WITH FLAT HOLE.

Blows per Minute.	Foot-Pounds per Blow.	Feet Drilled per Minute.
1272	48½	0.251
1222	43	0.206
1200	38½	0.198
1170	34½	0.135

A test was made under the following conditions: Ground hard; length of each test, 5 min.; drill, No. 8 water Leyner; 1⅛-in. hollow steel with 2¼-in. bit; holes nearly horizontal. In this test varying strengths of blow were obtained by means of stops of different lengths screwed into the ends of the valve chest. The results are shown in Table IV. Test *a* was first made and the results confirmed with test *b*.

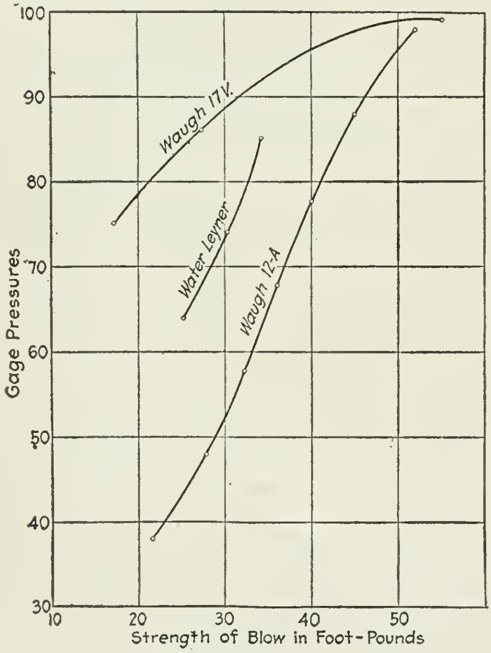

FIG. 2. EFFECT OF GAGE PRESSURE ON STRENGTH OF BLOW.

TABLE IV—LEYNER TESTS.

	Blows per Minute.	Foot-Pounds per Blow.	Feet Drilled per Minute.
a	1368	40	0.162
	1272	45	0.234
	1260	52	0.119
	1212	65	0.129
b	1368	40	0.135
	1272	45	0.224
	1260	52	0.183
	1212	65	0.195

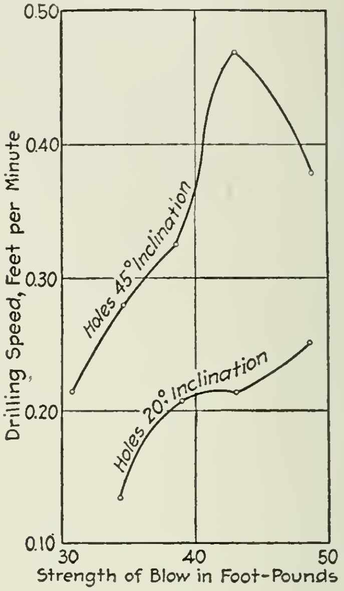

FIG. 3. INFLUENCE OF STRENGTH OF BLOW ON DRILLING SPEED OF AIR FEED STOPER.

As already stated, Table I indicates that for blows of equal strength the drilling speed is approximately proportional to the number of blows, even when these differ as much as 40 per cent. In constructing the curves of Figs. 3 and 4 from Tables II, III and IV, where the maximum variation in the number of blows is 15 per cent., the drilling speed has been arbitrarily adjusted according to the results obtained from Table I, so that the effects of the strengths of blow may be comparable.

These curves all show the same tendency to flatten at above a certain strength of blow, which in this ground happens to be about 45 ft.-lb. It will be noticed that the curves for the Leyner and for the stoper at 45° inclination are almost exactly similar. This is thought due to the fact that in each case the face of the hole is clear of cuttings. In the cases of the flat holes, which do not clear themselves, the drilling speed is not only lower, but does not show the same peak. This suggests that where holes can be cleared of cuttings a 45-ft.-lb. blow is sufficient to obtain the fastest drilling,

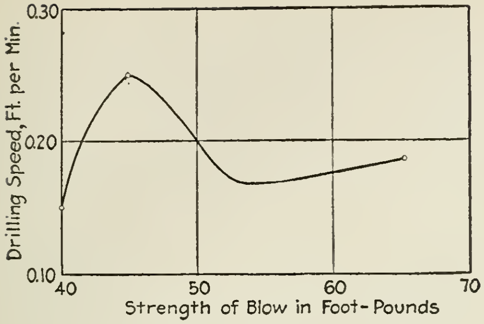

FIG. 4. INFLUENCE OF STRENGTH OF BLOW ON SPEED OF WATER LEYNER NO. 8.

whereas, in holes where the deadening effect of cuttings exists, the limit of effective blow is higher. This also emphasizes the desirability of a stoper with water feed to the face of the hole.

From these tests, and others giving similar results, it has been decided that for conditions existing at this mine, stoping drills should strike a minimum of 40 ft.-lb. As none of these drills has yet been found that strikes over 55, it remains solely a question of maintenance to keep them at this point.

The Leyner, with blows as high as 65 ft.-lb., presents a different problem. In this type the valve was so adjusted by means of standard plugs screwed into the ends of the valve chest, as to give at average gage pressure, blows in the neighborhood of 45 ft.-lb. It is hoped that this reduction in strength of blow will result in lessened breakage of steel, decreased repair costs, and maximum drilling speed. The adjustment has not been in use long enough to give any figures on the first two points.

The effect of setting the minimum strength of blow in the stoping drills at 40 ft.-lb. has been to increase the breakage of steel by 1 lb. per drill-shift, and the cost of repairs by 27c. per drill-shift. The footage drilled, however, has been increased 15 per cent., reducing the cost per foot of hole drilled from 20.3 to 18½c. The output per drill shift has increased 10 per cent. during the same period, but this figure is completed by the width of stope broken, and is therefore not quite comparable.

Examination of Table II shows the decrease in drilling speed that may be expected with a stoper striking 30 ft.-lb., as compared with 45 ft.-lb. Of this point it may be stated that many confirmatory tests have been made. Unless the drills are maintained at their best, the strength of blow drops rapidly (sometimes after 100 drill-shifts), with resulting decrease in drilling speed. The cost per drill-shift, however, remains practically the same. It is obvious what the result will be.

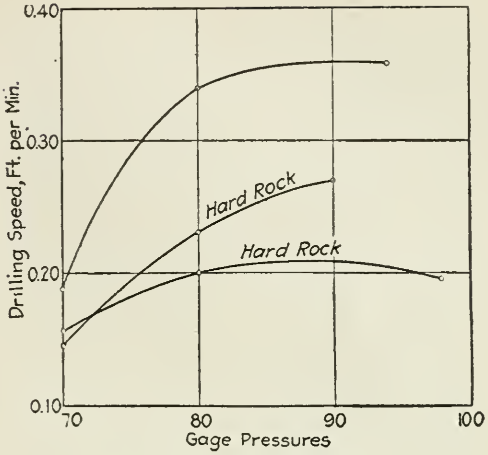

FIG. 5. INFLUENCE OF GAGE PRESSURE ON DRILLING SPEED.

MINERS IN HISTORY

BY HERBERT C. HOOVER.*

Coming now to authentic history, I may recall to you that Themistocles and Thucydides were miners, and I need but mention the Battle of Salamis to emphasize the miner's contribution to the preservation of civilization. Here the Asiatic was turned back from his attempt to subdue the West, when his success must have engulfed the civilization of Greece. It was the miners of Laurium who furnished the funds which built the Athenian fleet; it was a miner who directed the battle, and miners helped in the fight.

If type of metaphor stamps the calling of men, then we can claim Homer, Jeremiah and Virgil. Vulcan's workshop was described by no amateur, and as to the Golden Fleece, is it not an epic of the labors of many of our brothers? Jeremiah uses over a score of technical metaphors, and his generally pessimistic and peevish mind further confirms the hypothesis that he was a metallurgist by calling. At one place he says; "They are all brass and iron, they are corruptors, the bellows are burned and the lead is consumed in the fire. The founder melteth in vain, reprobate silver shall men call them." Here is anguish over metallurgic failure which could be epitomized only by one of the calling.

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*Extract from address upon receiving the medal of the Mining and Metallurgical Society of America.

To mention a few other figures of history, Philip of Macedon was a miner and founded his family and fortune on mines. The Athenian Nicias, the son of Nireratus, was a well known mine operator, but his attitude toward fellow professionals leaves something to be desired, for it is recorded that he bought a mine overseer for a talent of silver. While this price—equivalent to $40,000 in modern purchasing value—showed an early appreciation of proper fees, yet the buying of him lacked the delicacy of approach to professional engagements that we should have liked to find. There was also Diphilos, an engineer who was beheaded by Lycurgus for directing the robbing of mine pillars. I trust, in calling attention to this precedent, I shall cause no embarrassment to my Pennsylvania friends.

Demosthenes was on the borderland of our profession—he was a mining lawyer. Some of his earliest recorded orations before the Athenian Senate were delivered as counsel in mining cases. Theophrastus, who succeeded Aristotle as head of the Peripatetics, was a mineralogist. Theophrastus was the first author to assert that minerals propagate themselves and grow, and therefore he was the founder of the school of secondary enrichment.

Hannibal was a mining engineer and the son of a miner. Our confidence, however, in his technical abilities is a little dampened when we hear it asserted that in his long uphill fight against the Romans, he used vinegar to quench his fire-breaking of the Alpine roads. The frightened Romans, however, who record this, may have had the same illusions as to his engineering abilities that the news writers have of some of our modern colleagues.

There is also a *Praefectus Metallorum* who, in time of rebellion or strike of his miners, confined them underground and traded them food and water for ore. I have felt that he may have perhaps been worried out of the usual humane paths of our profession by the demands of some Roman Federation of Miners.

I need not repeat to you that after Roman times an almost complete eclipse occurred in all civilization and industry. Only after the lapse of centuries of historic darkness does the European world find itself, at the break of dawn, completely enthralled by the superstition of the Church and by the arms of the Feudal System. The masses were enslaved to the soil; the skilled workers were held rigorously to their hearthstones by primogeniture in calling; and the learned professions, except theology of the orthodox order, were held as heretical or dangerous to the state.

It is at this stage of the world's history that the miner performed what is to me the most impressive service that any calling has done for humanity, for it was the miners who rekindled the light of liberty which ended this darkest period of human history. Long before the awakening of learning, and long before the time of Agricola, the miners of Northern Europe had broken down the universal tyranny of feudalism. Earlier than the 10th century they had demanded and had been granted the free government of their own communities and industry; they had established their own officials and courts. The free mining cities of Saxony and Bohemia, the self-governing communities of Cornwall, Devon, the Forests of Dean and Mendip, and the High Peak of Derbyshire had blazed the way to representative government long before Mother of Parliaments sat at Westminster. They even led the way for the free merchant cities of the Baltic and England, and soon after the arrival of the Normans, we find in English history references to the "miner's right" to their "ancient liberties" and "customs," terms resonant of independence.

This fine spirit of independence seems to me to be a concomitant of the miner's calling, for not only do we discover it in all those times, but the life of our mining camps of the last ten decades is replete with it. None but men of intelligence and courage can serve in its ranks. Its daily work and daily experience are pregnant with enterprise and adventure There is yet another characteristic of the miner which, while not so evident in these days, yet stands out vividly enough in the past. The daily invasion into the unknown earth, the dead darkness in which his lamps serve to distort every shape, the uncanny noises of strained rocks, the approach of danger and death without warning, the sudden vanishing and sudden appearance of good fortune, have colored the miner's mind with distinct mysticism, and fallowed the field for religious fervor. But, not less, have all these experiences developed in his character courage, idealism, and self-sacrifice.

It was this spirit of mysticism, of courage, of independence, this free thinking and free governing in the free mining communities of Saxony which gave birth to the soul of Martin Luther. It was the miners of Saxony who rocked the cradle of the Reformation and it was the miners like Fabricius, and sons of miners, who formed the band who supported his life work. In this connection, I should not fail to mention an engineer nearer to our own times—Swedenborg. Of the same type of character was Georgius Agricola. Agricola was not a narrow slave of his profession. He was a man of deeply religious and courageous nature, the first citizen of his city, the distinguished servant of the state.

Aside from his great inventory of the professional stores of learning in *De Re Metallica,* we should all know that in the history of science and thought, it was Agricola who laid the first stone in the foundation of the modern structure of science. His long overlooked *De Ortu et Causis* is not only the first work on geology and ore deposits, but was the first production of science built upon deductions from observed natural phenomena. It was the first break from the dry scholasticism of the Middle Ages.

I will not dilate on *De Re Metallica,* for the book itself is its own recommendation. That it had an untold influence on the mining world is amply evidenced by the fact that it passed at least ten editions in three languages, and maintained its position as the text book of the profession for nearly two centuries. Nothing could bear higher testimony to its esteem and usefulness than that it was chained in iron bindings in the town halls, for miners to consult at will.

To me, one of the most interesting of Agricola's themes is his vigorous support of his profession. Despite the note of liberty first sounded by the miners of Europe, or perhaps because of it, the miners were not free from constant criticism and assault from the clergy and the scholastic classes, nor is our profession still free from occasional necessity to defend its right to esteem. It is now nearly four centuries since Agricola wrote: "Inasmuch as the chief callings are those of moneylender, the soldier, the merchant, the farmer, and the miner, I say, inasmuch as usury is odious while the spoil cruelly captured from the possessions of the people innocent of wrong is wicked in the sight of God and man, and inasmuch as the calling of the miners excels in honor and dignity that of the merchant trading for lucre, while it is not less noble, though far more profitable, than agriculture, who can fail to realize that mining is a calling of peculiar dignity?"

POCKETS OF DEAD AIR TOO MUCH FOR AN ORGAN BLOWING FAN

The matter of arranging ducts which convey air for one purpose or another is very often carried out without the slightest thought of keeping the system as a whole free from places in which air can become stagnant, and which, as a consequence, can prevent air from flowing past that particular point and set up a pressure which acts against the fan or other blowing apparatus. This fault is also met with in surface condensers in which spaces that are not swept out by the steam exist. Such spaces become filled with air, which is packed up into them under a slight pressure, and which is simply alternately compressed and re-expanded, and not removed, thus occupying valuable condensing space and, at times, making the condenser of little use.

The case which the writer has in mind is that which happened to a church organ in a small town in the Midlands. The writer visited the remarkably fine parish church in order to admire its architecture. Whilst looking round the chancel, a young fellow, who was trying to get the organ to play, asked the writer if he understood organs, as this particular one would not act owing to the impossibility of getting sufficient wind from the blowing engine. The writer, though not an organist, happens to be enough of a musician to feel sympathy for anyone in such a plight, and also being an engineer and, therefore, blessed with the "let's-see-what's-up-with-it" temperament, offered to look into the matter and see what could be done.

On going behind the organ the request was made to have the air ducts from the organ to the fan pointed out; these were followed up, and there were at least three places in which air could lodge and form a lock. The fan was situated in a basement and was driven by a small gas engine. What baffled the organist. who was a pupil come into practice, was that the church organist, who was his instructor, had come in with him and started up the engine, and then gone to keep an appointment in the town; the engine was running all right. and everything appeared in correct order, yet no wind could be obtained to keep the organ playing; a few feeble notes and then a dead stop was all that could be done. Suspecting an air lock, the writer told the musician to go up to the organ and to continue to play the instrument until he was asked to stop, whether the notes spoke or not. This was done, and, of course, tended to draw all air from the ducts as soon as the pressure in the air lock dropped and let the air pass to the pipes; to accomplish this, the engine was shut down, and left down for about five minutes. At the end of that time the engine and fan were again put into service, when, to the surprise of the musician and two friends who were with him, the organ shortly began to play in its usual style. In return, the writer was favored with one or two selections, and could not help smiling at the wonderment of the musician and his friends; "Why," they asked, "should stopping the engine and starting it up again settle matters?" and it was not possible to make them really see the effect of an air lock.

What had caused the trouble in this case was that the ducts had in them sufficient air in one of the bends to nearly fill that bend; when the fan was started up this air became compressed to a slight extent, and just gave enough back pressure to prevent the fan sending any air forward, the fan, of course, being fairly well loaded up with the work of churning the air which surrounded it. The bends in this case were square and at right angles, and there was a bad dip.—*Power User.*

GRAPHIC AIR COMPRESSION COMPUTATION

BY F. H. ROSENCRANTS.

In connection with compressed air work a common problem is the determination of the power necessary to compress a given volume of air from one pressure (usually that of the atmosphere) to some other higher pressure. It can be shown mathematically that the power absorbed in the cylinder by the air is:

$$hp. = \frac{144\,P_1\,V_1}{33{,}000} \times \frac{n}{n-1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

in which

P_1 = Absolute intake pressure in lb. per sq in.;

P_2 = Absolute discharge pressure in lb. per sq. in.;

V_1 = Volume of free air compressed per min. in cu. ft.;

n = Factor varying in air compressors from 1.25 to 1.35, depending on the efficiency of cooling by the jacket. A common value of this factor is 1.30.

This formula is long and tedious to apply, especially if one is not familiar with the use of logarithms and calculating devices. It is for the purpose of solving this formula graphically that Fig. 1 was designed. The heavy broken line X indicates how the chart is to be used, but possibly a brief explanation will make it clearer. The data for the problem solved is as follows:

Volume to be compressed per minute (V_1) = 24 cu. ft.; initial absolute pressure (P_1) = 14.7 lb.; discharge absolute pressure (P_2) = 114.7 lb.

Solution: Starting with the volume of 24 cu. ft. at the top of the chart drop vertically down to the diagonal line representing the intake pressure of 14.7 lb. From there follow to the right to a point between the two diagonal lines labeled 7 and 8 respectively, or to be exact to a point representing 7.8, the value of the ratio

$$P_2 \div P_1 = 114.7 \div 14.7 = 7.8$$

Then drop vertically to the answer of 4.1 hp. at the bottom of the chart. If a mechanical efficiency of 85 per cent. is assumed the indicated horsepower of the driving engine is

$$4.1 \div 0.85 = 4.82$$

It will be evident that a problem with the same data as above, except that V_1 be 240 cu.

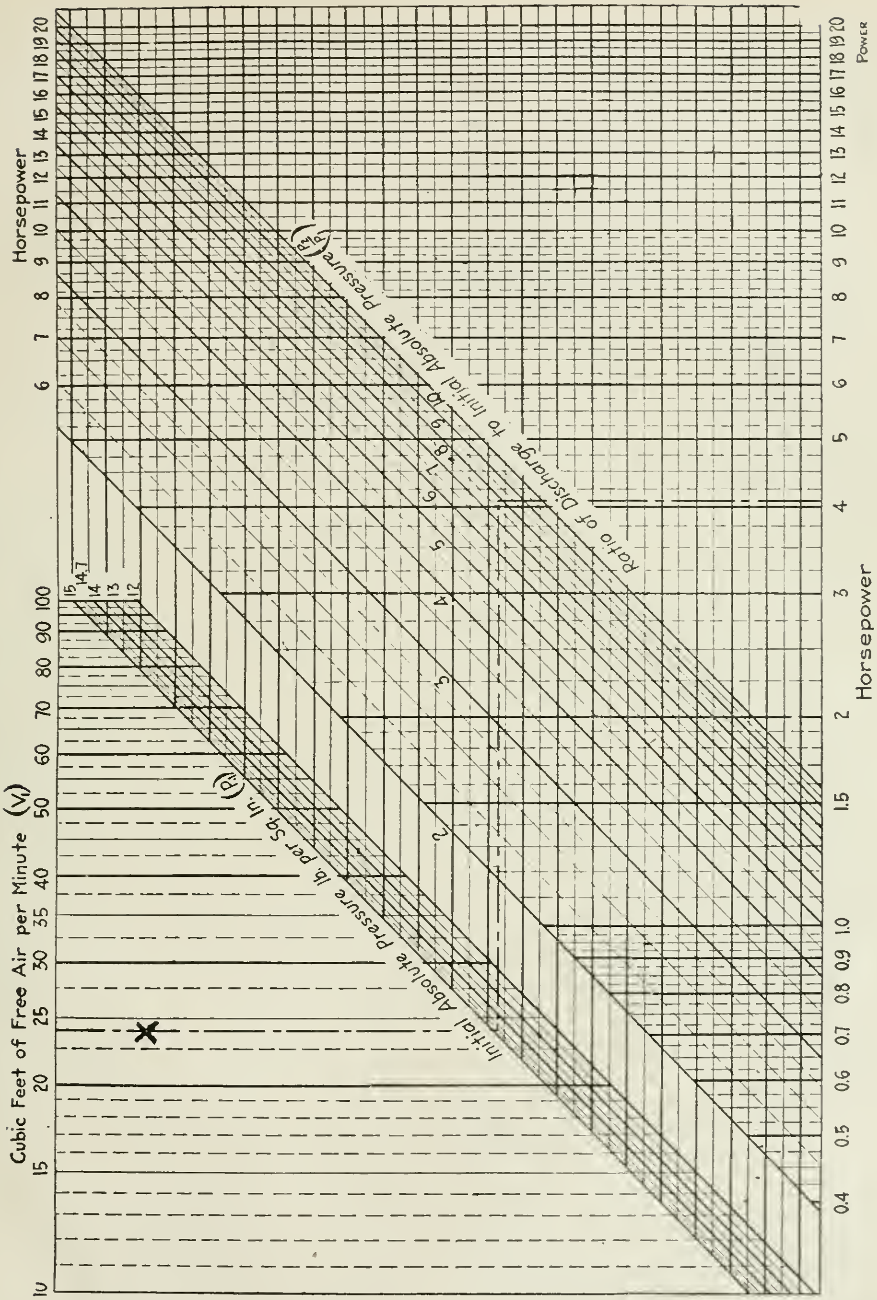


FIG. I. CHART FOR DETERMINING HORSEPOWER REQUIRED TO COMPRESS GIVEN VOLUME OF AIR FROM ONE PRESSURE TO A HIGHER PRESSURE.

ft. per min., would be solved by using the same line and that the answer would be 41 hp., the difference in the solution being in the placing of the decimal point. The range in volume of air on the chart being from 10 to 100 cu. ft. per min. makes the range unlimited by merely shifting the decimal point on the volume scale and making the corresponding change on the horsepower scale.

The value of the factor n for which the chart was plotted is 1.30. This figure was chosen because it is the value most commonly used. In Table 1 are given factors by which to multiply the results when *n* has a value other than 1.30. To illustrate its use assume that *n* in the above problem has a value of 1.40, the value for adiabatic compression of air. The proper factor by which to multiply will be found in the bottom line of the table 0.8 of the way between 1.059 and 1.063, which is equal to 1.062. Therefore, multiplying the chart answer of 4.1 hp. by 1.062 gives 4.35 hp., the desired result.

TABLE 1. FACTORS BY WHICH TO MULTIPLY RESULTS WHEN n HAS VALUE OTHER THAN 1.3

	Values of $P_2 \div P_1$								
n	2	3	4	5	6	7	8	9	10
1.20	0.976	0.962	0.953	0.946	0.941	0.936	0.932	0.927	0.927
1.25	0.988	0.982	0.977	0.974	0.971	0.969	0.966	0.963	0.962
1.35	1.008	1.017	1.020	1.024	1.028	1.031	1.033	1.036	1.038
1.40	1.016	1.029	1.039	1.048	1.055	1.059	1.063	1.067	1.071

The use of the chart is not necessarily limited to air problems, since by using the proper value of *n* it is applicable to any gas. In general the value of *n* is slightly less than the ratio of the specific heat at constant pressure to that at constant volume of the gas in question.

While the chart is primarily designed to solve problems for single-stage compression, it may be used also to determine the necessary power for two-stage compression. It can be shown that for the most economical results in two-stage compression the intermediate pressure should be equal to the square root of the product of the intake and discharge pressures; i. e., equal to $\sqrt{P_1 P_2}$. It may also be shown that for this intermediate pressure the work done in each of the two cylinders is the same. Therefore, having determined the intermediate pressure, which will be called P', the horsepower absorbed in each of the two cylinders is:

$$hp. = \frac{144\, P_1\, V_1}{33{,}000} \times \frac{n}{n-1}\left[\left(\frac{P'}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

the same formula which the chart was designed to solve. Therefore, having obtained the result of this solution from the chart the total horsepower absorbed in both cylinders is obtained by multiplying by two. To illustrate, assume the same data as for the above problem except that the compression is to be two stage.

Solution: The intermediate pressure is

$$P' = \sqrt{P_2 P_1} = \sqrt{114.7 \times 14.7} = 41.06\ lb.$$

Then the ratio of compression $P' \div P_1$ in the low-pressure cylinder is

$$41.06 \div 14.7 = 2.79$$

For 24 cu. ft. of air per min. and this ratio of compression, the chart gives a value of 1.80 hp. Therefore, the total horsepower absorbed in both cylinders is

$$2 \times 1.80 = 3.60$$

Assuming a mechanical efficiency of 85 per cent., the indicated horsepower of the driving engine is

$$3.60 \div 0.85 = 4.23$$

Fig. 2 becomes useful when it is desired to determine the necessary piston displacement of a compressor to deliver a definite volume of free air under given conditions of intake and discharge pressure. Also in calculating the probable amount of air that a compressor of given dimensions will deliver under given conditions of intake and discharge pressure and speed.

Referring to Fig. 3, representing the indicator diagram of an air compressor, it is evident that when the piston reaches the end of the compression stroke, corresponding to the point *A*, the clearance volume *C* will be full of air at discharge pressure. This air will expand as the piston starts back on the intake stroke and no air will be drawn into the cylinder until the pressure therein has fallen to the intake pressure. Hence the volume of air drawn in at each stroke will be somewhat less than the piston displacement, the amount being dependent upon the clearance volume and the ratio of the discharge to the intake pressure. The ratio of the air drawn into the cylinder per stroke to the volume of the piston displacement is called the volumetric efficiency of the compressor. In Fig. 3 this ratio is approximately $DF \div DE$. Mathematically expressed the volumetric efficiency is:

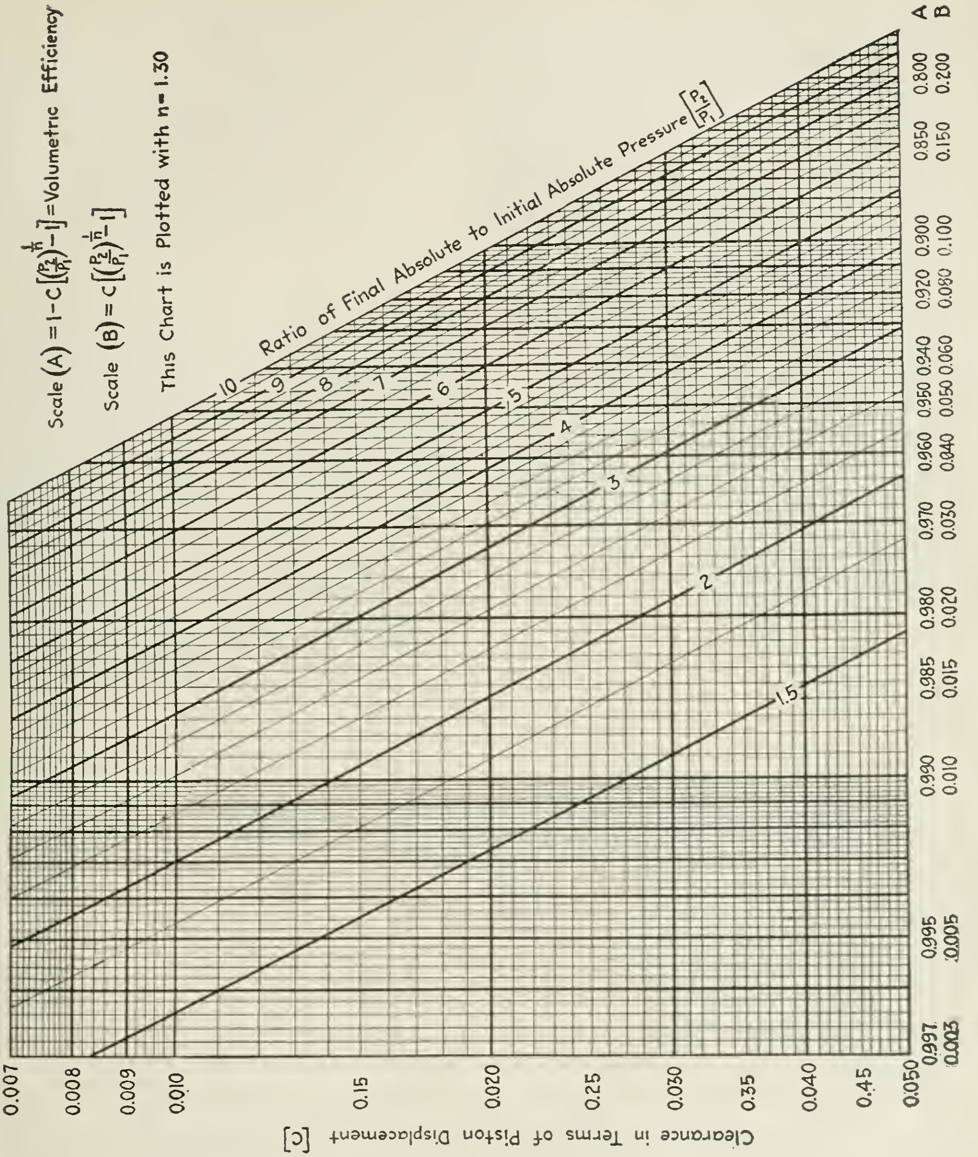


FIG. 2. CHART FOR DETERMINING VOLUMETRIC EFFICIENCY.

$$1 - C\left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]$$

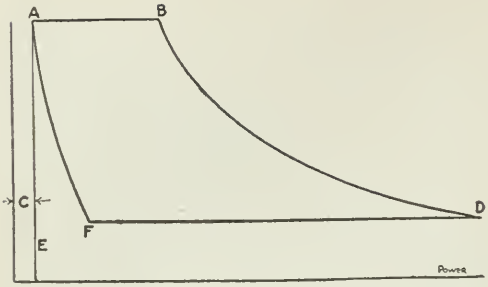
in which C is the clearance volume in terms of the piston displacement and the rest of the notation has the same meaning as in the previous formula.

Fig. 2 is for the purpose of solving this formula. The method of using it is self-evident, but to make it perfectly clear the following example will be solved.

Given: Clearance volume $C = 0.02$ of piston displacement; $P_1 = 14.7$ lbs. abs.; $P_2 = 75$ lb. abs.

Required: The volumetric efficiency.

Solution: Starting on the left-hand side of the diagram at 0.020 go in a horizontal direc-



tion to a point between the two diagonal lines labeled 5 and 6 respectively, or to be exact to a point representing the value of

$$P_2 \div P_1 = 75 \div 14.7 = 5.1$$

From there drop vertically to the answer on scale *A*, which for this case is 0.950.

To make the diagram applicable to problems in which n has a value other than 1.30 the scale *B* has been placed on the diagram. This is equal to 1 — scale *A*, or to

$$C\left[\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right]$$

To solve problems similar to the above when n has a value other than 1.30 proceed in exactly the same manner except that the result is read on scale *B*. Then multiply this by the proper factor from Table 2 and subtract the result from 1, giving the desired volumetric efficiency.

TABLE 2. FACTORS BY WHICH TO MULTIPLY SCALE B IN FIG. 2 WHEN n HAS A VALUE OTHER THAN 1.30

	Values of the Ratio $P_2 \div P_1$									
n	1.5	2	3	4	5	6	7	8	9	10
1.20	1.097	1.112	1.132	1.150	1.162	1.169	1.178	1.187	1.192	1.196
1.25	1.041	1.064	1.070	1.077	1.080	1.082	1.088	1.091	1.093	1.095
1.35	0.959	0.950	0.941	0.936	0.932	0.929	0.927	0.926	0.924	0.922
1.40	0.918	0.907	0.892	0.886	0.880	0.872	0.866	0.864	0.860	0.857

As a last example involving the use of both charts, take the following problem: A single-stage compressor is desired which will compress 2000 cu. ft. of free air per min. from a pressure of 14.7 lb. abs. to a pressure of 70 lb. abs. What should be the piston displacement per minute, and what should be the indicated horsepower of the engine, assuming a mechanical efficiency of 85 per cent.

Solution: From Fig. 1 the power absorbed in the cylinder by the air is 238 hp. Then

$$238 \div 0.85 = 280$$

as the indicated horsepower of the driving engine.

From Fig. 2 the volumetric efficiency is found to be (assuming a clearance of 2 per cent.) 0.954. Dividing 2000 by 0.954 gives 2096 cu. ft.

To allow for leakage past the piston back through the discharge valves, for effect of rise in temperature during the suction stroke, etc. this quantity should be increased by from 3 to 8 per cent. Therefore, assuming the loss due to these causes to be 5 per cent., the required piston displacement becomes

$$1.05 \times 2096 = 2200.8 \textit{ cu. ft. per min.}$$

—Power.

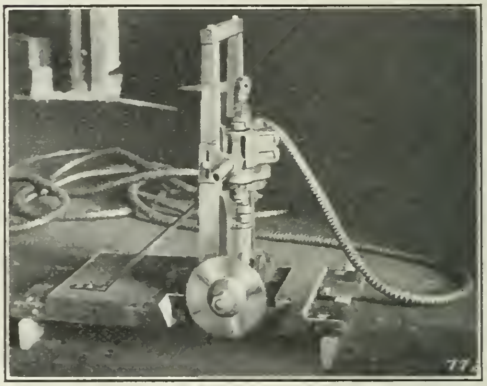


FIG. 1. PORTABLE AIR DRIVEN SAW.

PNEUMATIC LABOR SAVING IN MANUFACTURING

BY CHARLES C. PHELPS

A large New England textile mill has devised several novel ways of using pneumatic drill motors in connection with the work of making alterations and repairs to its buildings. As a result it is making a considerable saving in both time and labor. In many of the processes of textile manufacturing, the looms, spinning frames, and the like, are arranged in rows, leaving alleys between rows for the operators. In time the flooring of these alleys wears down and it becomes necessary to replace it. Ripping up the floor by hand tools means not only a loss in production, due to interference with the machinery and operators, but is slow work and consequently expensive in itself.

The device shown in Fig. 1 was designed to do this work by means of a circular saw. A pneumatic drill motor is mounted on standards attached to a rolling platform. The saw is connected by bevel gearing to the drill spindle. The handles of the drill are held by metal plates bolted to the sides of the upright frame and the spindle has a bearing in a saddle which is also bolted to the uprights; thus a rigid construction is secured. The motor is a light one, weighing about 15 lb. and operating at about 500 r.p.m. The saw is about 6 in. diameter and is geared to a high speed. In the illustration, the device is shown raised from the floor. In use, the saw is so set as to make a cut the depth of the floor boards. Guide cleats are first nailed to the floor on either side of the alley, then the operator pushes the machine along on its rollers, making a straight cut in hard maple at the remarkable rate of 20 ft. per min., going right through any obstructions, as nails, just as though they did not exist. In softer woods, this speed could be doubled or trebled.

This same device is also used for sawing the new strips of flooring. The tool and its mounting are inverted and set in a special framework with a mitering guide for cutting off the wooden strips on an angle and to exact length. By laying the new flooring on an angle, it was believed that it could resist wear better.

A similar arrangement is useful for cutting out portions of roofing, preparatory to patching. In fact, the device illustrated has been used for this purpose occasionally.

By substituting a rotary planer for the saw or placing a disk faced with sandpaper on the end of the motor spindle, this device could be used for resurfacing flooring.

CUTTING SLOTS FOR BELTING

In many mills the machinery is driven from countershafting on the floor above and the belting must in such cases pass through slots in the floor. This arrangement is often used in a weave room to avoid the nuisance of dirt and dust falling from shafting on the ceiling and also so as not to interfere with the lighting. A convenient appliance is in use at this same mill for roughing out the belt holes in the floor, when new machines are to be installed. It consists of a pneumatic wood-boring auger mounted on an adjustable frame. The wooden base is made in the shape of an H, having a rectangular frame hinged to it at the center and so arranged that it can be set quickly at any angle desired and clamped in this position. The auger is fed by hand in the usual way, the device serving simply to guide the auger. It assures a clean-cut hole at the right angle. This method is fully three times as rapid as the old method of roughing out by hand.

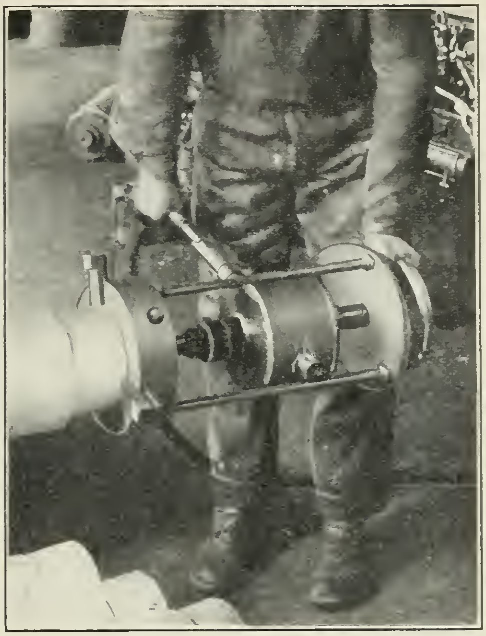


FIG. 2. RECENTERING SHAFTS.

RECENTERING SHAFTS

Fig. 2 illustrates a simple but convenient centering device for use with pneumatic drills. Here it is shown recentering a number of shafts, which are ready for the final turning and grinding after having been roughed out and cut off to length. The device would prove equally valuable to any shop or mill which has to turn a large number of cylindrical metal or wooden parts as rolls, or squeezers; with slight modifications, it could also be used to advantage for boring or drilling holes for shafts, axles, and the like. A universal lathe chuck is connected by three rods with a casting at the back through which the feed screw of the drill passes. The three rods serve as guides for the drill motor. The drill chuck fits a central bushing in the large chuck, thus insuring accurate centering. The universal chuck is quickly secured on the end of the work by the usual socket chuck-wrench. The operator then controls the air supply with his right hand and turns the feed wheel with his left.

An interesting application of a pneumatic

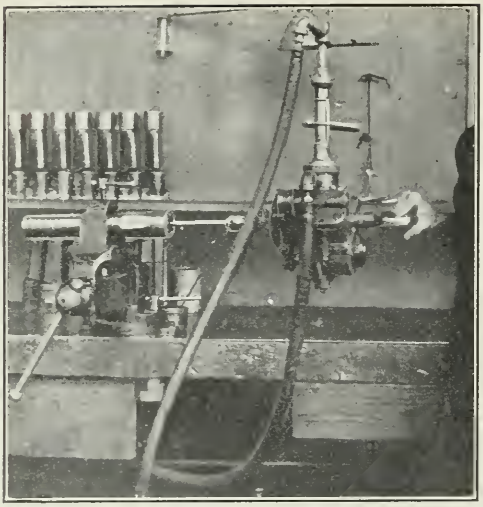


FIG. 3. LAPPING CYLINDER.

wood-boring auger used for lapping the cylinders and valve chambers of riveting and chipping hammers in a shop manufacturing pneumatic tools, is shown in Fig. 3.

The pneumatic motor is suspended from the ceiling by means of a chain and, in place of the auger bit, a rod having a cylindrical plug of suitable material fastened to the end, is inserted in the socket of the machine. The plug is the same size as the drill piston. After applying abrasive powder, the throttle is opened and the plug rotates while the operator pushes the lapping tool into the barrel and withdraws it, repeating the operation several times. Ordinarily, the operation of this motor is controlled by a ribbed throttle sleeve on the side handle. A short lever has been attached to this handle, as shown above the motor in the illustration, so that the control is convenient. The motor is of the reversible type; by reversing the motion the lapping operation is very efficient. The lower handle of the drill, which is a "dead" handle, has been removed and a plug inserted in its place. It will also be noted that a length of hose is attached to the exhaust elbow, so as to conduct away the exhaust air instead of letting it blow around the work. The riveter or chipper barrel is held securely in a vise, but is pivoted so as to permit of slight play, which greatly aids in inserting and operating the lapping tool. The pivoting device is clearly shown in the illustration.

Fig. 4 shows a novel manner of using a pneumatic motor in connection with a lifting jack. Jacks containing a plunger actuated by pneumatic pressure have been in use for a long time, but the motor-driven type, shown in Fig. 4, which is known as a "Cayuta" screw jack is of very recent development. The plunger types have certain limitations which restrict their field of usefulness within somewhat narrow limits, but the latter type has a remarkable speed and is made in capacities up to 35 tons.

A regular pneumatic drill motor of suitable size and speed fitted with No. 3 or No. 4 Morse socket is employed. A special extension socket is clamped into the drill socket and fits over the square end of the jack operating spindle. In addition, there is an auxiliary ratchet mechanism that can be operated by hand if desired.

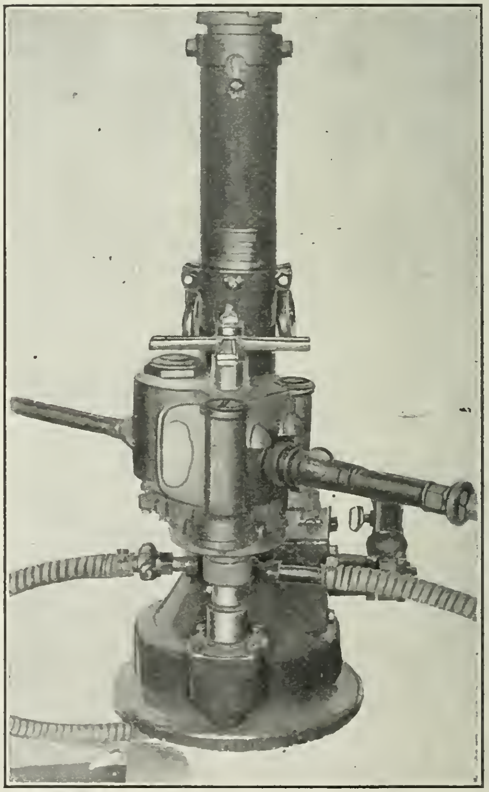


FIG. 4. AIR MOTOR ON SCREW JACK.

If several jacks are in use in one location, one or two motors are sufficient to take care

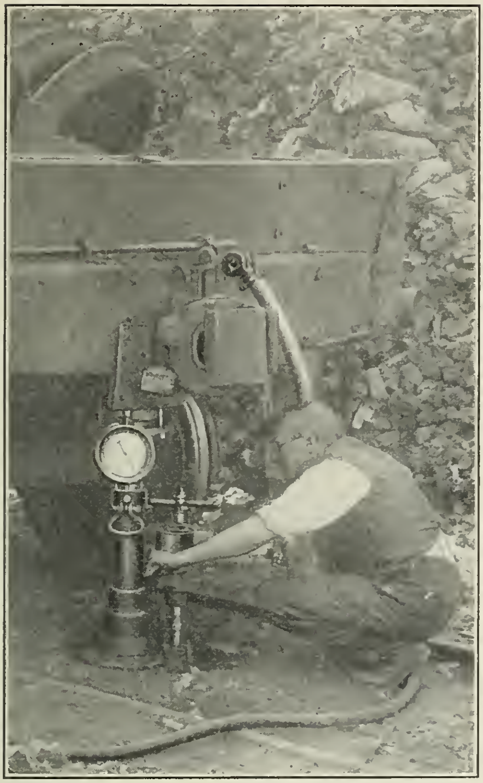


FIG. 5. LIFTING LOADED CAR.

of them. The speed of operation of the jack ranges from 6 to 12 inches of lift per minute, which is probably at least 10 to 20 times faster than standard screw or hydraulic jacks. The motor is conveniently fitted with a short length of hose and quick-detachable coupling so that it can be connected into place without loss of time. Fig. 5 shows one of these jacks employed for lifting the frame of a flat car.

Pneumatic motors of various kinds have rendered excellent service for operating large valves. Four large gate valves in the water mains of a large California city are operated by means of pneumatic drill motors, the valve stem being geared to the spindle of the pneumatic motor. Of course, motors of the reversing type must be employed for such service. These valves are opened in about 2 minutes, whereas it formerly took two or three men 10 minutes. In this case, it was first intended to operate the valve with an electric motor, but the ingenuity of the engineer in charge led him to save this expense by utilizing compressed air, which was already available.

A somewhat similar use is found for small air motors in a New England paper mill, where several 10-inch gate valves at the bottom of pulp digesters are operated by pneumatic motors. These valves have to be opened and closed frequently and the plan adopted has proven far more economical than the old way of manipulating by hand. The power is transmitted by belting from the motor to a pulley on the valve stem.

In another instance, a drill motor of only a fraction of a horsepower, was used for driving a slow-acting but fairly heavy filter press through worm gearing.—*American Machinist.*

FORTY-FIVE YEARS OF AIR BRAKE EVOLUTION

BY A. L. HUMPHREY.*

Forty-five years elapsed between the first trial of the air brake and the death of George Westinghouse. The introduction of the air brake was only its birth. It has had a strenuous infancy, an eventful youth and a recent past of wonderful development. Maturity it cannot reach until transportation by rail ceases to progress. The quick action triple valve, brought out by Westinghouse in 1887, and the high-speed feature of the passenger train brake, added in 1894, have rendered a continuous service which in length of time, universality of application and degree of excellence is unapproached by any other mechanical device in common use at the present time upon railways.

A train in 1890, weighing 280 tons and going sixty miles an hour, had an energy of 33,000 foot-tons. The best air brake of that day could not stop that train in less than 1,000 feet. A train in 1914, weighing 920 tons and going sixty miles an hour, had an energy of 111,000 foot-tons. With the 1890 brake the 1914 train could have been stopped in perhaps 1,760 feet. As it passed the 1,000-foot mark it would still have a collision energy of 48,000 foot-tons (one and one-half times what the 1890 train had before the brake was applied), and it would still have 760 feet to run. That 1914 train with a 1914 brake can be stopped in 860 feet. At that point the same train with an

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*Condensed from *Scientific American.*

1890 brake would still be running forty-three miles an hour, with a collision energy of 57,000 foot-tons, or about twice that contained in the 1890 train at the beginning of the stop.

THE BRAKE GIVES MORE THAN SAFETY.

The train running at speed can now be quickly stopped. What follows? That you dare run it at speed. And how does speed effect economy? By increasing the revenue which can be earned in a day by the crew; by the locomotive, which can haul a longer and heavier train; by the car, which will hold more tons; by the trackage, which can accommodate more trains a day; by the traffic solicitor, who can bring more freight and passengers if service is quicker. It is not alone that longer and heavier trains and more of them can be operated at speed, because the air brake will stop them when there is danger. Countless station stops, slow-downs and applications while descending grades are made to one emergency stop. The time saved in such routine operations and the larger use of plant, especially at junctions and terminals, due to quick stopping, is one of the most important results accomplished in the whole brilliant history of organized railway endeavor. Is it surprising that the railways have given and are more and more giving the most eager and systematic co-operation to the manufacturer in the development of air brake improvements?

High speeds, heavier vehicles, longer and heavier trains and their greater frequency increased the amount of work required of the stopping device. The effort consumed in stopping a given train going twenty miles an hour is four times that required at ten miles per hour. The brake shoe, which performs its function through friction against the wheel, is at a disadvantage, which is aggravated as the amount of work required within a given distance increases. A further loss occurs as the greater force is exerted through the foundation brake rigging and because of the longer time taken to obtain full braking power with large cylinders and larger trains. With longer trains, also an increase in the volume of air used interferes with the prompt and uniform response of the brakes to the manipulation of the valve, both when applying and releasing. This makes recharging more difficult and demands a larger available supply of compressed air. Another tendency which was manifested with enlarging train units was that the time elapsing between the action of the brakes at the head end and at the rear end of the train caused a bunching or stretching out of the its smooth handling.
slack between cars, and this interferred with

To enable the brake mechanism to perform this augmented and more complex task, the most obvious and essential step was to insure the best of use of the device as it stood. A poor brake well maintained and operated in the best possible manner will give better service than the best brake if neglected or carelessly handled. This meant systematic instruction of those responsible for handling of trains in service and for the care, inspection and maintenance of the brake mechanism. Both railroads and manufacturers developed trained corps of experts and special methods and apparatus for testing and repairing and provided technical literature and instruction paraphernalia, including elaborately equipped instruction cars and rooms. By organized efforts along these lines increasingly severe service requirements were for a long time partly offset by closer inspection, better maintenance and more care and skill in the handling of the equipment in service. The nature of the mechanism, itself, however, has been rapidly and radically modified.

LATER AIR BRAKE IMPROVEMENTS.

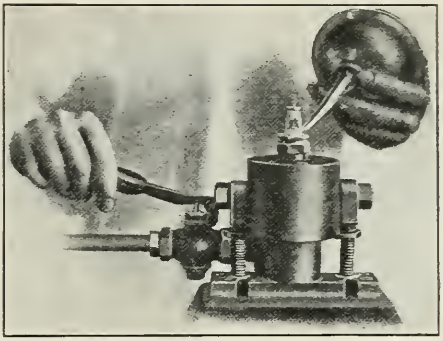
The brake apparatus, in the first place, has been reconstructed so that the mechanism on each car assists in propagating the application in routine as well as in emergency use, thus insuring the prompt and uniform action of all the brakes and affording a more responsive brake for the train as a whole. In "releasing," uniformity and certainty are attained by automatically restricting the release and recharging of the brakes at the head end of the train. This insures greater certainty of response of the brakes toward the rear end of the train and a more uniform action on the train as a whole, and is a large factor in preventing the shocks and strains which cause rough handling and break-in-twos.

To meet down-grade conditions the "empty and load" type of brake has been evolved. Instead of the ordinary brake, designed to control the empty car, and about one-third as efficient with a loaded car, we have for heavy grades the "empty and load" brake providing a braking force on each car substantially in proportion to its weight. The more uniform braking of loaded and empty cars improves level as well as mountain-grade service, since any inequality of braking effort on different vehicles in mixed trains of loads and empties produces rough slack action and damaging shocks.

Increased consumption of compressed air took place through greater loss by leakage for longer trains and larger cars, through greater actual use on the larger cars and in more frequent and heavier brake application. To augment the supply of compressed air, compressors of large capacity and high efficiency have been developed.

While the brake could be made quicker acting and more powerful by propagating the application through the train more rapidly, by raising the cylinder pressure and by shortening the time required in obtaining this high maximum pressure, thus making substantially safer the passenger train with heavier cars, it came to be recognized that full results depended upon transmitting the enhanced and quickened pressure to the rim of the wheel efficiently and without material loss. This brings us to the foundation brake rigging—the brake beam and levers—and the brake shoe. Inefficiency in these parts of the mechanism made it impossible to reduce the length of emergency stops on heavy passenger trains going sixty miles an hour to less than 1,200 feet with the most powerful and rapid-acting brake then available. The result has been a highly efficient "clasp" type of rigging; two brake shoes to the wheel instead of one greatly improved the performance of the rigging and relieved the brake shoes, trucks and journals of excessive and unbalanced forces to such an extent as to permit the stops already described at well under 1,000 feet.

Routine or "service" stops, as previously pointed out, are second in importance only to emergency stops. The service functions have been improved so that a fully effective automatic or manual emergency application is possible, even at a moment when a "service" application is in progress. In case the brake-pipe reduction is continued below a fixed minimum danger point an emergency application is made automatically. By the use of electro-pneumatic control the application and release of all brakes can be made uniform and simultaneous throughout the train.



AIR PRESSURE TEST FOR SPARK PLUGS

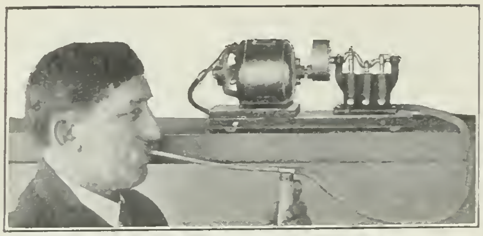
The disadvantages of a leaky spark plug are many and apparent. Not only does leakage cause a loss of power but the constant rush of inflamed gas through the leak will overheat the plug, cause preignition, which develops engine knocks, and in time the extreme heat will destroy the packing and break the insulator. Even the slightest leak will cause trouble. Incorporated in the severe tests to which the Champion Ignition Co., Flint, Mich., subjects its AC plugs, is one to overcome any possibility of a spark plug leaving the factory in a leaky condition. Each plug undergoes an air test.

The plug under test is inserted in a special fixture and air under a pressure of 150 pounds to the square inch is turned on. The operator then floods the plug with a liquid in such a way that the slightest leak will be indicated by a bubble. Should even the slightest leak occur, the plug is rejected.

Each AC plug is, therefore, perfectly gas tight when it leaves the factory. Further than this the plug is so constructed that it can be taken apart and reassembled without impairing its gas tight properties. This effect is obtained by a copper asbestos gasket and steel washer assembly that insures a tight plug with a minimum of pressure on the insulator.—*Automobile Topics.*

VACUUM TREATMENT FOR PRESERVING TEETH

Pyorrhea—a disease whose symptoms are the inflammation of the gums and the loosening and final loss of the teeth—is a very common malady. It is claimed that half of the persons older than 40 and many younger suffer from it, and that to this cause more than



to any other is due the loss of teeth in old age.

This disease has proved a very stubborn one to control. It is caused by tartar forming between the gum and the tooth, which results in ulceration and the formation of pus. About the only treatment that has so far been possible has been to clean out the tartar and inject antiseptics between the tooth and the gum; but the dental profession has recognized that this procedure is inefficient because it tends to keep the gum and the tooth separated instead of helping them to grow firmly together.

Inventive ingenuity has aided in solving this difficult and important problem. The Sanitor, a machine manufactured by the Sanitor Company, of Chicago, is claimed to provide a successful method of treatment. It is practically a vacuum pump driven by a 1/30 h.p. Westinghouse electric motor. The manner of its use is shown in the illustration. A rubber vacuum cap fits over the teeth and gums, and the little pump applies an intermittent suction. Hence all pus is drained out of the tooth pockets; the gums are thoroughly massaged, and a full flow of fresh, healthy blood is induced. The machine is of course to be used only upon the advice of a competent dentist.

COMPARISON OF RECORDS OF PERCUSSION AND HAMMER DRILLS

The following is the concluding portion of a valuable paper by Mr. Charles E. Hart before the West of Scotland Branch of the Association of Mining Electrical engineers.

The Loeschberg Tunnel was driven by 3⅝-in. diameter percussive rock drills, and the highest footage drilled per month was 1,013 ft. in the soft rock and 574 ft. in hard rock, the average for six months being 342 ft. The heading measured 6½ by 9½ ft. At the Simplon Tunnel, the highest footage was 755 ft. and 426 ft. for six months. At the St. Gothard Tunnel, the highest footage per month was 563 ft. In the Elizabeth Lake Tunnel, in America, the heading was 12 by 12 ft. in granite and the highest footage per month was 466 ft. At the Gunnison Tunnel the heading was 8 by 12 ft. in granite and shale and the highest footage per month was 449 ft. The machines used in the above were invariably of the large-diameter percussive type, but in the Simplon, Brandt rotary drills were also employed. The record footage for one day was done by Messrs. Rothblitz during the construction of the Loeschberg Tunnel; it was 43.3 ft. Last year, however, this record was broken by Messrs. Julius Berger, of Berlin, in the construction of Hauenstein Tunnel in Switzerland, the highest footage for one day being 48.5 ft. This tunnel will be 8 kilometres (nearly 5 miles) long, and the whole work is being done by hammer drills.

This, of corse, does not prove that the hammer drill can bore faster than the percussive rock drill, but it goes to prove its adaptability. Their economy and the comparative boring speed is dependent on conditions and the nature of the rock. The chief interest, however, lies in the fact that they are now being used for this class of work with marked success, which further justifies the contention that they are becoming the prevailing drill. To compete with the hammer drill in point of cost, the percussive machine must do 2½ to 3 times as much work in a given time, owing to its greater cost, greater air consumption, and greater labor required. For instance, taking 100,000 cu. ft. of air per hour at 80 lbs. pressure as costing, say, 15s; in eight hours actual boring time, the percussive rock drill at 120 cu. ft. per minute consumes 56,000 cu. ft. of air, equal to 7s. 6d.; while in the same time a hammer drill taking 30 cu. ft. per minute would consume 14,400 cu. ft., equal to 2s. 1d. The following may be taken as a fair average of what a hammer drill will do, provided good drill steel is used with correctly tempered bits:

	Inches Per minute.
Boring speed in hard granite	4
" " " ordinary granite ...	6½
" " " ordinary whinn	5
" " " hard whinn	4
" " " limestone	10
" " " freestone	10
" " " coal	8 to 24

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COMPRESSOR AND DRILL DEVELOPMENTS

One of the greatest and most unfailing of all the businesses of New York is its own business of growing. An increase of over one-sixth of a million in population every year must be provided for by a constant reaching out into new lands all around it, building upon it and fitting it with all the facilities of urban life. Water, sewerage, illumination and transportation are all to be provided for, and in all these the engineer, or, more properly, the engineering contractor is a principal agent, There are always jobs awaiting him in the city just as surely as for a lawyer.

Of all the public utilities for which the contractor is responsible the one which seems never to catch up with the demand is that of local passenger transportation. New lines of urban and interurban travel are inadequate from the moment of their completion. The existing subway system, which was at first a wonder merely for its magnitude and its vast carrying capacity, is uncomfortably, indecently, and even dangerously overcrowded at certain hours.

Just now the construction of other and still more omnivorous subways is getting under way and we are specially interested in some of the devices employed upon the work. As all depends upon the contractor so he is dependent upon the mechanical facilities which may be available, and chief among these are the air compressor and the rock drill. These have an established status and are both absolutely reliable under suitable conditions, but with both of them constant strenuous employment has led to successive improvements which have greatly increased their efficiency.

Efficiency is the life of the successful contractor, and he unhesitatingly pays the price. The big steam power houses for the compressors were all right when they were the up-to-date thing, but they were costly both to instal and to operate and in the later contracts they are conspicuous by their absence. Instead we see—when we can find it—the small electrically driven plant, more numerous and more conveniently located with little cost for attendance. It is also noiseless, which is one of the changes which have come to the compressor itself. An entirely new system of air valves, both for inlet and discharge, phenomenally light and free of movement, give clearer passage for the air and permit increased speeds with commensurate augmentation of capacity.

There has come over the rock drill and rock drilling practice a greater change than that which has befallen the air compressor. It is not, however, that the drill has been improved so much, but that it is being superseded. The reciprocating drill is giving way to the hammer drill. The tripod drill, with its heavy weights, requiring the constant attendance of two men, is giving way to the one-man drill, which wastes no time from hole to hole, accomplishes more work day by day, and with a great reduction in operating cost.

It is idle to discuss how and why these changes are occurring. The self-interest of the contractor has been the final arbitrator, and while he has been seeking only his own profit his decision must have weight wherever air compressors and air actuated rock drills are employed.

NEW BOOK

Pumping by Compressed Air, by Emund M. Ivens, New York, John Wiley & Sons. 250 pages, 6x9 in. 106 illustrations, numerous tables. $3.00.

Just one-third of this book is devoted to air compression, air compressors and related matter already to be found in many books and with nothing new or original. In fact no originality can properly be claimed for any portion of the book. Various information is presented concerning the different systems of employing compressed air for raising water, numerous formulas and tables from various sources are given which should be of service to those who have no better means of informing themselves on the subject.

HAMMER DRILL SHANKS

BY PARIS HIATT.

The introduction of Hammer Drills has brought with it some new points in the making and handling of drill steels which up to the present time are not as thoroughly understood as they should be in order to get the best results from this type of drill. Inasmuch as the writer has made a special study of this class of work during a number of years, both in America and in Europe, he feels that a few words on this subject will be of benefit to many

In all types of hammer drills where the hammer or piston strikes the steel directly, it is necessary to make a special shank on the steel, with a collar set at a certain point to prevent the steel from extending too far back in the chuck, and thus shortening the stroke of the piston. The cross section and dimensions of collar and shank are determined by the type of drill. The important point, however, is to keep the shank to the proper size and length, with a square, smooth striking surface.

When a shank becomes broken it should be removed at once from the machine, as in a very short time the striking face of a piston or hammer will be ruined when working on a broken or uneven shank end. Also small pieces of the broken shank are liable to work back into the machine and score the cylinder. Likewise when the striking end of a piston becomes broken it should be replaced at once, as one bad piston will ruin many shanks in the course of a day. There are several ways in which a drill operator can tell when a piston or shank breaks, the most common of which is by sparks flying from the front head.

In other types of hammer drills, in which the hammer or piston strikes an anvil block, which in turn strikes the steel, no collar is necessary on the steel, as the anvil block prevents the steel from extending too far back into the machine. However, the length, cross section and striking face of the steel should be given as much attention as in the former type. Too small shanks produce excessive wear on the chucks, and bad striking ends will ruin the anvil blocks.

The proper temper for shanks depends on the quality of the steel, but in all cases an easy way of testing is with a file. If the file slips over the shank end, not taking hold, the temper is too high and the shank will break. If the file takes a firm hold on the shank end the temper is too low, and the shank will upset in the chuck. So a happy medium, namely when the file just touches the shank end, is the proper hardness and should be rigidly adhered to. A good method for inspecting shanks and one that takes but little time, is to supply the blacksmith's helper with a suitable gauge and when he sorts the steel for the fire he can quickly apply the gauge and lay the bad shanks in a pile for repairing.

Both in the blacksmith's shop and underground the steels should be stood with the bits down. In solid steels this keeps mud and dirt from the shanks and in hollow steels it keeps dirt from the hole in the shanks, which is very important for the following reason: The hole in the bit is usually conical with the bell of the cone outward, corresponding with the blacksmith's punch; therefore the point of the cone is usually smaller than the hole in the steel and dirt passing through the steel from the shank end will usually stop at this point and then the hole is plugged. For the same reason it is more difficult for dirt to enter the steel from the bit end, and what collects in the cone can easily be knocked out by a few raps of the steel against a stone. This point is extremely important in steels for drills that have a water tube extending a short distance into the shank, for in such steels the hole for the tube is larger than the hole in the steel, and if dirt is in the shank the water tube will be plugged or broken as the steel is inserted in the chuck. A little care and system in the handling of steels will not work a hardship on either the miners or blacksmiths, but will save endless trouble underground, in the blacksmith shop and in the repair room.

At the present time the writer knows of only one machine which has proved a practical success in making all types of shanks and drill bits; this is the Leyner Sharpener marketed by the Ingersoll-Rand Co. It accomplishes the work both rapidly and accurately by means of shank end formers, upsetting dies and forming blocks. Furthermore, the experience is in the machine itself, and in many places it is being worked satisfactorily by most ignorant workmen.

St. Petersburg, Russia, July. 1914.

SNOWSTORM HYDRO-ELECTRO-PNEUMATIC POWER COMBINATION

A novel hydro-electro-pneumatic installation has recently been made by the Snowstorm Mining Co., operating in the Coeur d'Alene district, Idaho. The plant consists of a 300-hp. air compressor, rope driven by a Pelton water wheel and an induction motor direct-coupled and working either independently or in parallel with the water wheel unit, when the latter rotates at 347 r.p.m.

Due to the variable water supply available for the wheel, and the continuous operation required of the compressor, it was necessary to install a 250-hp. electric motor to help out during the period that the water wheel was unable, from lack of water, to drive the compressor at the required load and speed.

Current for the motor is secured from a transmission line of a commercial plant supplying the district. Mounted on the electric motor shaft is a 46-in. rope sheave which drives a 14-ft. sheave on the compressor. The compressor sheave is grooved for nineteen 1¼-in. Manila ropes, and the sheave is cast with sufficient weight to permit obtaining the requisite fly wheel effect for the compressor's operation. The American system of rope transmission is employed, the tension sheaves and re-winders being placed above the driving ropes, and located in such a manner as to conserve floor space and head room to the greatest extent.

The water-wheel equipment consists of a twin runner Pelton-Doble tangential water wheel unit; one runner being approximately 44 ins. in diameter, and is capable of developing 325 hp. when running at a speed of 347 r.p.m. This speed also coincides with the full load speed of the induction motor. The other wheel is approximately 72 ins. in diameter and develops 250 hp. at a speed of 212 r.p.m. Both water wheels are keyed on the same shaft, which is extended and coupled to the electric motor shaft, carrying the driving sheave. One or the other wheel must develop the requisite power when running at its correct speed; in this event the idle wheel, the pressure water being shut off from same, simply rotates on the shaft without performing any work other than providing additional fly-wheel effect for the installation. Both wheels never develop power at the same time.

The requirements of the plant call for the highest efficiency over a wide range of operating conditions, involving approximately a 300 per cent. fluctuation of the power water supply, and a variation of the compressor speed, hence the power required for same depending upon the demands on the air line. It is necessary, during certain times, that 300 hp. be delivered to the compressor sheave when the latter rotates at 95 r.p.m.

If there is sufficient water available the 44-in. Pelton wheel develops this power without assistance from the electric motor. Should the water supply be insufficient, current is applied to the electric motor to supply the deficiency. At other times, and over a period of several hours' duration, the compressor output is reduced to an amount corresponding to 58 r.p.m. In this event the water for the 44-in. Pelton wheel is shut off and it rotates idly, while the 72-in. Pelton wheel is allowed to develop the power, without assistance from the motor. While either wheel may develop its full power when operating at its correct normal speed of 347 r.p.m. for the 44-in. wheel, and 212 r.p.m for the 72-in. wheel, quite a wide variation of speed below normal may be secured; hence a most flexible installation has been secured.

The novelty of this plant consists of the application of a variable speed, variable power tangential water wheel unit to a constant speed induction motor, driving a compressor. The plotted efficiency curves of the water wheels is quite flat for a range of power between 220 and 300 hp. for the 44-in. wheel when rotating at 347 r.p.m, and for the 72-in. wheel between 160 and 230 hp. output at 212 r.p.m.

For slight reductions of speeds below normal the efficiency holds up remarkable well, as was predicted. These results are obtainable from the type of ellipsoidal water wheel buckets employed in conjunction with needle regulating nozzles. The latter discharge a perfectly circular, solid jet under variations corresponding to full load of the respective wheels, down to about 10 per cent. of the maximum load.—*Min. and Eng. World.*

HAMMER DRILLS AND PERCUSSION DRILLS COMPARED

BY P. B. MC DONALD.*

Drill steels can be changed more quickly with a hammer machine than with a reciprocating machine because the steel rests loosely in the chuck and does not require the careful tightening which a reciprocating drill chuck does. The time spent changing drills may seem only a small detail; but it is noticed in the records that half as much time was consumed in doing that as in net drilling time, so that for 2 hours of actual drilling as much as one hour might be spent in changing steel. It is wise to economize on such an important detail.

The mounted, screw-feed, hammer drill can be set-up, adjusted to the correct distance from the face of the rock, and the holes pointed advantageously, with greater facility than a reciprocating drill, because the stroke of the machine is taken care of in the cylinder and does not affect the drill steel or chuck. It helps to save time in several of these auxiliary operations. In starting a new hole with a reciprocating drill, especially a "cutting-in" hole at a glancing angle to the face of the rock, the air can only be turned on half-force for a few minutes or the blows would slide off the rock. As a hammer drill uses many light blows in place of a smaller number of heavy blows, the holes can be started with more precision, and inequalities on the surface of the rock are not so likely to deviate the drill.

There can be little doubt that a hammer type drill is theoretically a more efficient and scientific machine for cutting a hole than is a reciprocating type. In the latter type power is consumed in overcoming friction and inertia of the drill-steel. This in a six-foot length of hole may be a considerable item, due to the drill steel rubbing against the sides of the hole as it is reciprocated and turned. In the hammer type the only weight moved is the hammer alone, which imparts all its energy through the drill-steel to cut the rock. More practical, if smaller, considerations are that the miner's helper is not liable to have his knuckles barked by a reciprocating and rotating chuck, and the miner can feed the machine ahead until the chuck fairly touches the rock, whereas with a reciprocating drill, he would probably stop it an inch from the limit of the feed, due to not being able to distinguish the whereabouts of the swiftly moving chuck. These are small points, but it is on record that miners have refused to use a certain make of machine because the crank-handle was not rounded, but was so sharp-ended as to hurt the hand of the man who turned it.

The hammer types have some disadvantages In the earlier makes difficulty was experienced in keeping the cutting face of the drill-steel close against the rock, so that the full force of the blows was sometimes lost. The latter types, more carefully made, have improvements which obviates this.

In a hammer drill, the drill-steel may be struck over a thousand blows per minute. From 10 to 15 per cent. of these blows may be

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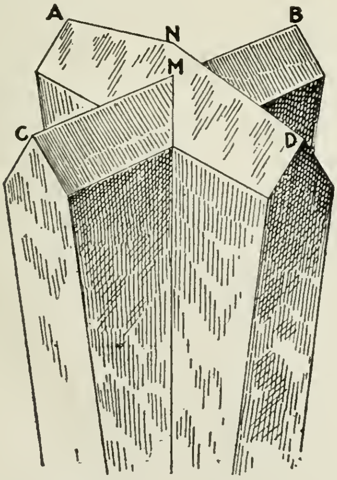
*Extract from article in *Canadian Mining Journal,* June 15.

struck when the bit does not touch the bottom of the hole, because a piece of hard steel cannot be hammered and pressed against rock without bouncing back. The troubles of broken drill-steel are due partially to this, but are not serious with good steel.

Also there are some varieties of rock, clayey or sticky, which drill better with a drill-steel churning and plunging in the muddy chippings, which refuse to wash away, than with the hammer drill. The reciprocating drill splashes the hole clean, better than the hammer type, in such rock.

As to the advantages of the "stoper" hammer drills or of the hand sinkers, such as the Jackhamer, little need be said. It is pretty well accepted that the one-man stoper drill has revolutionized over-hand stoping and raising all over the world. In many mining districts, as on the Marquette Range, Michigan, an enormous number of stopers are in use. In a few districts, such as the Birmingham iron mines, Alabama, they were tried and not liked. The little hand-sinkers have risen suddenly to fame for down-holes, especially since automatic rotation types came out. For shaft-sinking they are time-savers, as much for the facility with which they can be taken out of the way at blasting time as on account of the much greater number of machines which can be operated in the confined space.



A NEW KINK IN DRILL BITS

The sketch here reproduced from Engineering and Mining Journal, sent in by Mr. Frederick W. Foster, shows a bit designed by H. Emens which has been used exclusively for the last two years at the Portland mine, Victor, Colo. During the year after its use, there were 34,000 fewer bits sharpened than during the preceding year, while 7 per cent. more drilling was done. These bits are made of the same steel as the old ones, the only difference being in the fact that one set of wings is raised in the center. The raised part acts as a guide for the rest of the bit and causes the cuttings to come out coarser. The wear on the bits comes at the edges, the centers not being worn appreciably. The points *A, B, C, D,* are in the same plane. On 1 1-2 in. bit *N* is 3-16 in. above *M.*

A NEW SWISS TUNNEL

The Hauenstsin Tunnel on the Basle-Olten line in Switzerland was holed-through on July 10. The tunnel is 5 miles 94 yards long and was commenced Feb. 1, 1912. It and its approach lines will replace the existing line between Sissach and Olten. There is practically no difference between the lengths of the old and the new lines. On the former there is a tunnel a mile and a half long; there is a gradient of 1 in 38 for about 4 miles, and the rest of the route has a gradient of 1 in 48. On the new route the maximum gradient will be 1 in 95, and in the tunnel the gradient will be 1 in 133 for 4½ miles and 1 in 666 for the remainder. The contract price for the tunnel was a trifle under $4,000,000. It has been thus far completed about eighteen months ahead of the contract time.

FISHES AT GREAT DEPTHS

On the cruise of the Prince of Monaco in the North Atlantic in the summer of 1913, interesting studies were made of species of fish which normally inhabit depths of over 3,000 feet in the ocean, and which come as near the surface as 300 feet, during the night only. As the pressures at the depths mentioned would be over 1300 and 130 lb. per sq. in., respectively, the fish have a facility of decompression and recompression which New York sand hogs might envy. In the American Museum of Natural History, New York, there is an exhibit of models of deep sea fishes with an ingenious arrangement for showing their phosphorescent or self illuminating peculiarities.

NOTES

The cut on page 7349 of our September issue, showing the "works" of a pneumatic electric air drill built by the Pneumelectric (not Pneumatic as carelessly misprinted) Machine Company, Syracuse, N. Y., should have been credited to Engineering News, from whose page it was taken.

A big floating dock is being constructed at Odessa which is said to be the largest in the world. It will cost about $2,000,000 and will be capable of carrying a vessel of 40,000 tons.

In draining Kerr lake at Cobalt, Ontario, the pumps removed 325,000,000 gal. of mud and water at an average of 6000 gal. per minute for 38 actual working days.

A lately developed use of compressed air is for the cleaning of furs previous to their storage for the summer. A nozzle is used with a very minute opening, say 1-64 inch, and 4 to 6 inches long. This is carefully run all over the fur to dislodge dirt and eggs, which it does thoroughly and without injury.

The great Chicago, Milwaukee & St. Paul Railroad tunnel through the Cascade Mountains, in the State of Washington, which is 12,000 ft. long and will reduce the altitude of the crossing 443 ft., was broken through by a blast August 4, and men from east and west clasped hands through the gap. The tunnel will save four miles in distance and will avoid the enormous snowfall of the summit.

Some 12,517 men are now at work in the construction of subway systems in New York City, according to the last report of progress of Alfred Craven, chief engineer of the Public Service Commission. It appears that more than half the work is now under contract, but that when all contracts have been let, a matter perhaps of only a few months, the number of men will be almost doubled. The city has $126,414,000 in contracts, in progress or completed.

A novel wax bleaching plant at Bruitford, England, consists essentially of an electrically driven blower, an air cooler, a battery of five ozonizers, and the vessel in which the material is treated. The ozone produced is led to the bottom of the treating vessel, and passes up through the molten wax in fine jets, effecting the bleaching of the wax.

The Central R. R. of New Jersey will install a large electro-pneumatic interlocking system at the new station and yard in Jersey City, N. J. On completion of these improvements this road will have a continuous electro-pneumatic system, both for interlocking and block signals, on the four-track line from Jersey City terminal to Bound Brook, N. J.

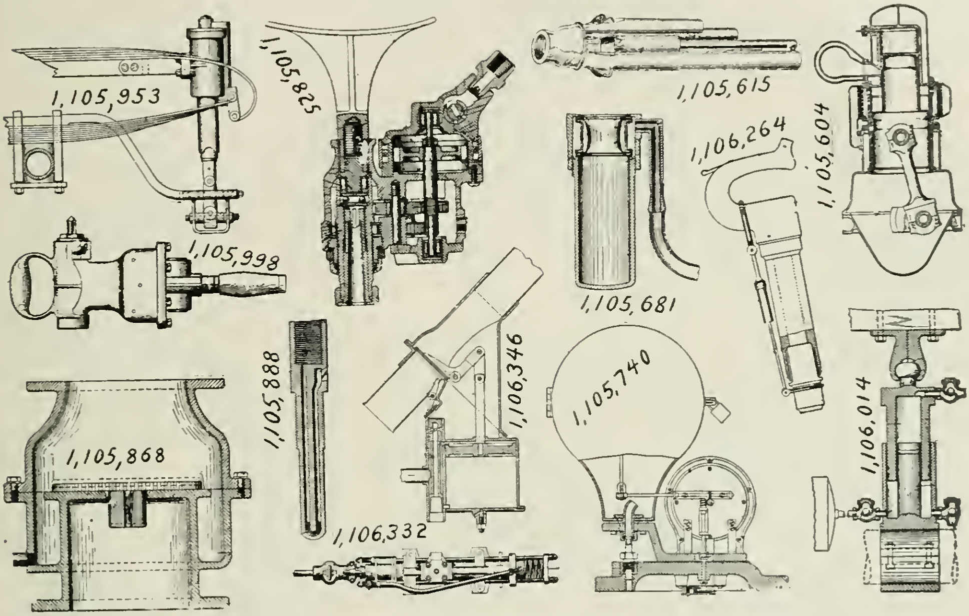
One pound of carbon burned to carbon dioxide (CO_2) gives 14,540 B.t.u., but if burned only to carbon monoxide (CO), it gives only 4380 B.t.u., or only about 30 per cent. of its full value. Oil burned to (CO) gives about 60 per cent. of its full value; therefore, as regards heat development, the more complete the combustion is, the better. However, to obtain complete combusion to (CO_2), it is ordinarily necessary to supply considerably more than the theoretical proportion of oxygen.

Dynamite inserted in lengths of condemned fire hose was used to cut to pieces the steel drill barge "Teredo" which had been sunk at Panama by an accidental explosion. It having been found impracticable to raise it, it was decided to cut it to pieces. The hose with its charge of explosives was placed along the line at which it was desired to direct the force of the blast and, according to the "Canal Record," made a fairly clean cut. The sections sheared off were raised by wrecking barges assisted by a dipper dredge.

Professor Vivian B. Lewis said, in a recent hearing before the Hayward's Health Gas Co., that if they mixed 5 per cent. or more of petrol vapor with air, they got a mixture which would burn quietly and was not explosive, but it was explosive between the limits of 5 per cent. and about 1.6 per cent. of petrol vapor. A gas which had only got 1.8 or 1.6 per cent. of petrol vapor in it was highly explosive.

The fastest time ever made in American waters by any sort of craft was made on July 3, 1914, by the hydroplane "Kitty Hawk VI" on the Illinois River at Peoria, Ill. A measured mile was covered in 1 min. 6 sec., or at the rate of 54.54 miles an hour. This tiny vessel, only 23 ft. long, has a 24-cylinder gasoline motor, generating 300 hp. at 1,600 revolutions per minute.

At Mt. Morgan Mine, Queensland, Australia, all the underground air mains are arranged so that they may be used also as water mains, carrying water at high pressure for emergency fire service. The arrangement is said to be highly satisfactory.



Pneumatic Patents August 4.

Electric Lights for Use in Gas Charged Rooms should be low candlepower carbon lamps, acording to tests made by the Bureau of Mines. These tests showed that when incandescent lamps of high candlepower were broken in an atmosphere charged with inflammable gas, the gas was ignited in a large proportion of the cases.

Three cases are reported (in England) of oil explosions in the crank chambers of high-speed engines. Two of these occurred in gas engines and the other in a steam engine, all the engines being of the enclosed type with superposed cylinders. The constant agitation of the lubricating oil by the engine cranks not only raises the temperature in the crank chamber, but causes a fine spray or mist of oil to be produced. This mist contains oil particles in such a finely divided state that it requires only a spark or overheated surface to cause ignition. In the case of gas engines the trouble has been overcome by the removal of the combustible gases by means of plenum ventilation.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 4.

1,105,604 ENGINE CONSTRUCTION. Charles H. Bartlett, Elizabeth, N. J.

1. In an engine construction, a foundation structure including a crank case, an air compressing cylinder, a working cylinder in tandem arrangement with the compressing cylinder, and a supporting housing for the compressing cylinder, an air reservoir or receiver located between the compressing cylinder and housing, connections between the air receiver and working cylinder for admitting compressed air thereto, and a valved connection between the air receiver, and the compressing cylinder.

1,105,615. AUTOMOBILE-HORN. Charles J. Brinkmann, Glencoe, Minn.

1,105,669. RIVET - SET RETAINER. Axel Levedahl and Reinhold A. Norling, Aurora, Ill.

1,105,681. SUCTION-CUP FOR MILKING-MACHINES. Otto A. Moldenhauer, Watertown, Wis.

1,105,740. VOLUME AND PRESSURE REGISTER FOR FLUIDS. Thomas B. Wylie, Pittsburgh, Pa.

1,105,825. PNEUMATIC TURBINE - DRILL. Reinhold A. Norling, Aurora, Ill.

1,105,868. EXTRACTOR OF LIQUORS AND SOLIDS FROM GASES. John T. Wilkin, Connersville, Ind.

1,105,876. PNEUMATIC TOOL. Gottlieb Briegel, Fond de Lac, Wis.

1,105,888. HOT-BEARING ALARM. Elmer O. Davis, Denver, Colo.

2. A device of the character described constructed to be used in connection with the air supply system to the brakes of a train, comprising a casting having a U passage formed therein, an air pipe connecting one end of said passage with the train supply system, and the other end of said passage free to exhaust to the atmosphere, the casting so constructed that the loop of the U passage may be placed and held in proximity to the bearing of a wheel axle, and a fusible plug located in the bend in such a position that as the bearing becomes heated to a great degree, the plug will liquefy and be discharged from the passage by the pressure of the air thus permitting the air to escape and reducing the pressure to such an extent that the brakes will be set.

1,105,942. SUCTION CLEANING APPARATUS. Edward M. Waring, New York, N. Y.

1,105,953. PNEUMATIC SHOCK-ABSORBER. Ralph E. Bates, Philadelphia, Pa.

1,105,987. GAS AND AIR MIXER. William B. McSorley, St. Louis, Mo.

1,105,998. FLUID-OPERATED DRILL AND HANDLE THEREFOR. Caid H. Peck, Athens, Pa.

1,106,014. SHOCK-ABSORBER. Raymond R. Walker, Follansbee, W. Va.

1,106,202. MILKING - MACHINE. James C. Gordon, Calgary, Alberta, Canada.

1. In a milking machine, a teat press comprising a sectional plunger adapted to manipulate a teat, fluid pressure cylinders, connections between said cylinders, a piston in each cylinder, a piston rod connected to each piston and to one of the sections of said plunger, a spring within each cylinder and holding the piston therein normally against movement under the action of fluid pressure and of a strength different from that of the spring in the other cylinder, and a source of fluid supply for said cylinders whereby the pistons therein will be actuated successively against the action of the springs.

AUGUST 11.

1,106,371. ART OF CARROTING FUR. Phillip C. Donner, Summit, N. J.

3. An improvement in the art of carroting fur which consists in blowing cut raw fur into a receptacle at the top and spraying a carroting solution into said receptacle at the top into contact with the moving fur therein.

1,106,411. HAIR-DRYING COMB. George L. Scheel, Chicago, Ill.

2. A device of the kind described comprising a comb having a hollow body with both ends thereof open; a spider in said body near one end thereof and having a recess therein; a cap provided with a recess therein and fitted in the other end of said body; a heating element disposed in said hollow body and supported in said recesses; and air pumping means connected with one end of said body and adapted to force air over said heating element, substantially as described.

1,106,537. ROCK-DRILL. George J. Beaudin, Flat River, Mo.

1,106,681. PRESSURE - INDICATOR. William H. Sauvage, New York, N. Y.

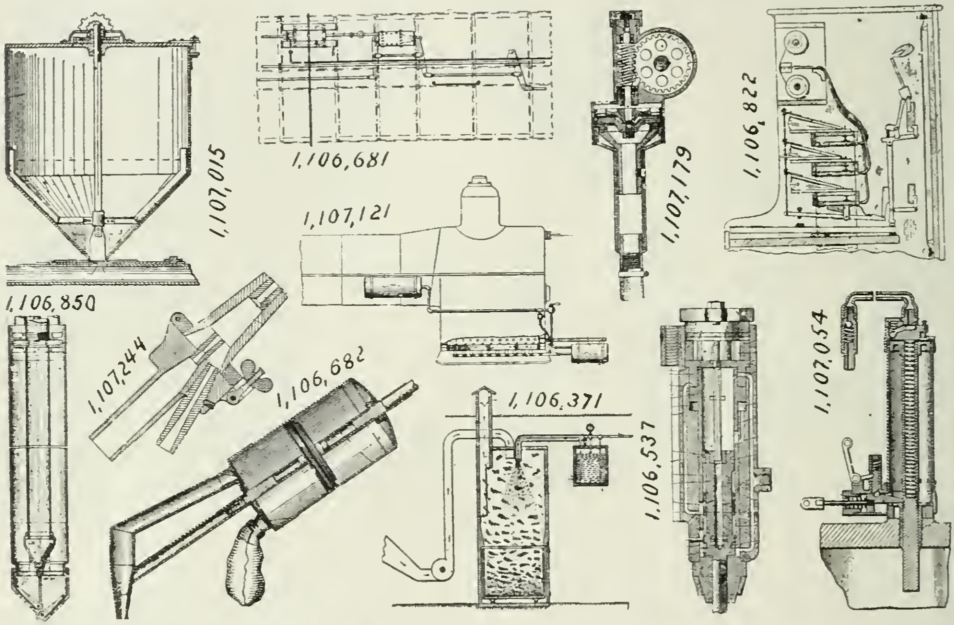
1,106,682. SUCTION - CREATING MECHANISM FOR VACUUM CLEANING APPARATUS. Julius Schirra, Pittsburgh, Pa.

1,106,695. NOZZLE FOR PNEUMATIC CLEANERS. John F. Boyn, New York, N. Y.

1,106,820. PLAYER - PIANO PNEUMATIC BELLOWS. Joseph Knagge, Chicago Heights, Ill.

1,106,822. PNEUMATIC PIANO. Clayton A. Lambert, Indian View, Ohio.

1,106,850. DEEP-WELL PUMP. John L. Sebastian, Salt Lake City, Utah.



Pneumatic Patents August 11.

1. In a deep well pump, the combination of exterior and interior cylinders, webs connecting said cylinders and dividing the space between them into chambers, a head fitting snugly within the exterior cylinder and connected to the upper end of said interior cylinder, and having apertures registering respectively with the interior cylinder and the chambers, a discharge pipe connected with the interior cylinder, a jet pipe communicating with the discharge pipe above said interior cylinder, pipes connected with said chambers for supplying compressed air thereto and exhausting therefrom, a valve casing connected to the lower end of the interior cylinder and having openings communicating with said chambers, a valve adapted to alternately close said openings, an inlet casing connected to the lower end of the exterior cylinder having a partition forming with said casing compartments respectively communicating with said chambers, said compartments having inlet openings, and non-return valves closing said openings.

1,106,937. AUTOMATIC REACTING SIPHON AIR-PUMP AND STOPPER. Abbot Porter Goff, St. Joseph, Mo.

1,107,015. DUST - SPRAYING MACHINE. Henry D. Babcock, Leonardsville, Frank C. Wells, Holland Patent, and Jay W. Brown, River Forks, N. Y.

1,107,054. PUMP ATTACHMENT FOR MOTOR-VEHICLE ENGINES. Frederick G. Folberth, Cleveland, Ohio.

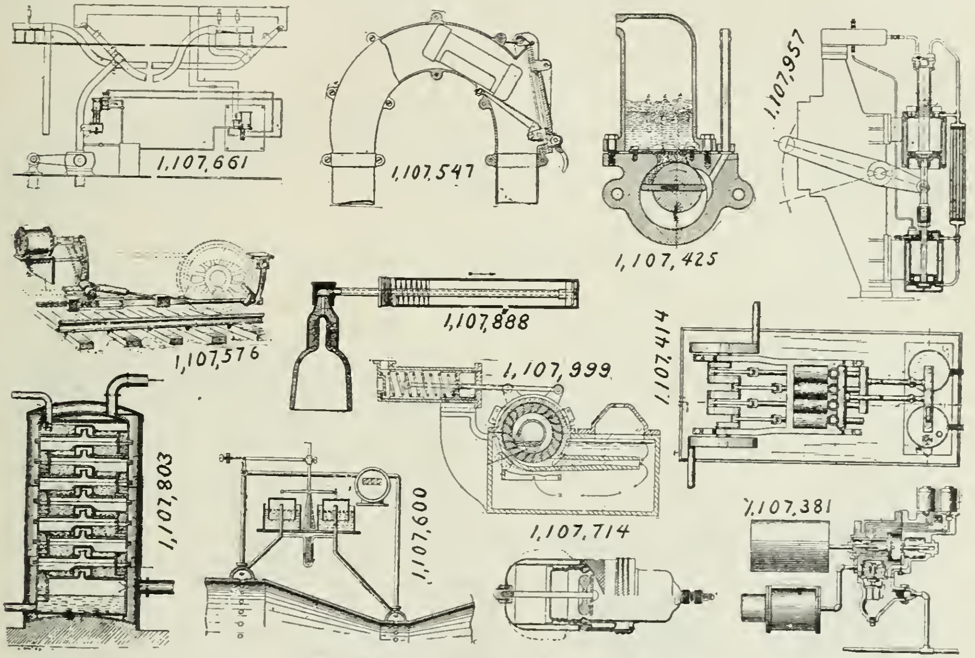
1,107,121. AIR-FEEDING AND AIR-OPERATED GRATE. Albert E. Shultz, Pinners, Va.

1,107,179. PNEUMATIC TOOL. Oscar W. Norberg, Alamosa, Colo.

1,107,244. SAND-BLAST NOZZLE. Albert Carter, New York, N. Y.

AUGUST 18.

1,107,284. VALVE STRUCTURE FOR AIR-COMPRESSORS AND THE LIKE. John Willis Gardner, Quincy, Ill.



Pneumatic Patents August 18.

1,107,381. ELECTROPNEUMATIC BRAKE. Walter V. Turner, Edgewood, Pa.

1,107,414. DIVER'S AIR-PUMP. Jean F. Deray, Sunnyvale, Cal.

1,107,425. VALVELESS PUMP FOR CONVEYING GASES. Walter Hohagen, Charlottenburg, Germany.

1,107,547. PNEUMATIC-DESPATCH - TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.

1,107,550. PNEUMATIC HAMMER. George Lawson Robertson, Philadelphia, Pa.

1,107,554. PNEUMATIC ACTION. Adolf A. Steinhilber, Rock Island, Ill.

1,107,564. VACUUM STREET - SWEEPER. Edward K. Ward, Davenport, Iowa.

1,107,571-2-3-4-5. AUTOMATIC PNEUMATIC MUSICAL INSTRUMENT. William F. Bayer, Buffalo, N. Y.

1,107,576. AUTOMATIC ADJUSTING DEVICE FOR BRAKES. Charles Albert Booth, Brunswick, Md.

1,107,600. REGISTERING-METER FOR GAS AND THE LIKE. Walter H. Fulweiler, Moylan, Pa.

1,107,661. PNEUMATIC-DESPATCH - TUBE APPARATUS. Merton L. Emerson, Braintree, Mass.

1,107,714. PNEUMATIC SPRING. Archibald Sharp, London, England.

1,107,744-5. APPARATUS FOR THERAPEUTIC TREATMENT OF AIR OF A SICK-ROOM. Frank Batter, St. Johns, Oreg.

1,107,803. PROCESS OF SEPARATING THE HYDRO-CARBONS CONTAINED IN NATURAL GAS. Heinrich Koppers, Essen-on-the-Ruhr, Germany.

1. Process of separating hydrocarbons contained in the natural gas which consists in driving said gas under pressure into a wrought iron jacket, and conveying the gas from said jacket into a cast iron bell washer inclosed by the jacket and containing a hydrocarbon-dissolving oil, whereby the bell washer is subjected to like exterior and interior pressure.

1,107,888. THERAPEUTICAL VACUUM APPARATUS. Charles E. Buck, Boston, Mass.

1,107,957. APPARATUS FOR COMPRESSING AIR AND OTHER ELASTIC FLUIDS. Edwin W. Jones, Ipswich, England.

1,107,999. ROTARY ELASTIC-FLUID PUMP. Joseph Petermoller, Cathcart, Glasgow, Scotland.

AUGUST 25

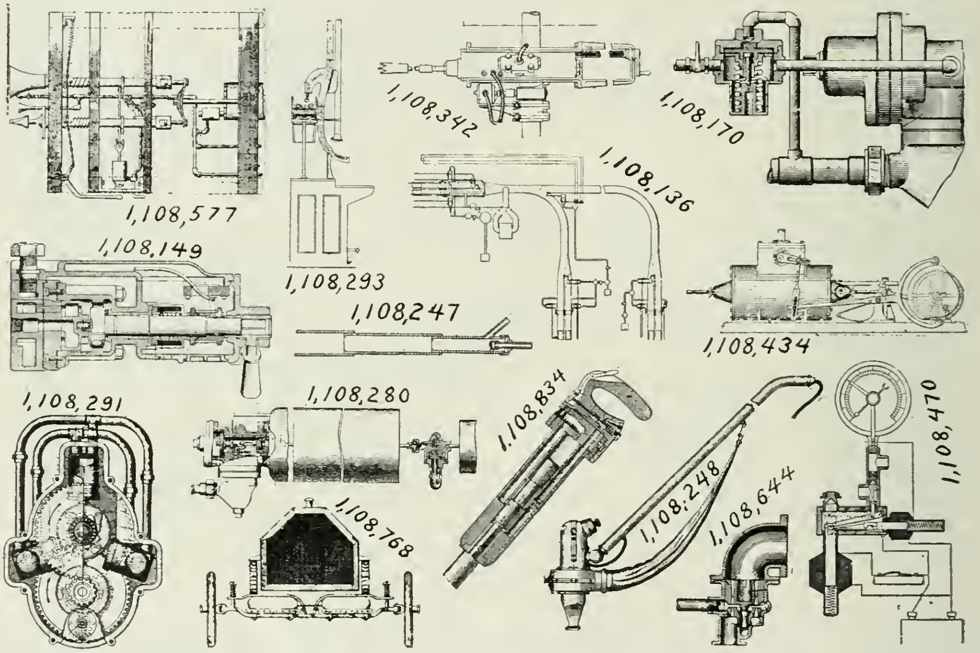
1,108,136. PNEUMATIC-DESPATCH APPARATUS. Roderick G. Collins, Jr., New York, N. Y.

1,108,137. APPARATUS FOR CONTROLLING THE MOVEMENT OF CARRIERS IN PNEUMATIC-DESPATCH APPARATUS. Roderick G. Collins, Jr., New York, N. Y.

1,108,149. ELECTROPNEUMATIC BRAKE-VALVE. Edward H. Dewson, New York, N. Y.

1,108,170. PRESSURE-RETAINING-VALVE DEVICE. Theodore A. Hedendahl, Denver, Colo.

2. In a fluid pressure brake, the combination with a train pipe and triple valve device, of a valve for controlling the release of air from the brake cylinder through the triple valve exhaust port, a movable abutment subject in one direction to train pipe pressure tending to close the valve and in the opposite direction to brake cylinder pressure tending to open the valve, and means for neutralizing the effect of the train pipe pressure on said abutment to a predetermined extent.



Pneumatic Patents August 25.

1,108,247. VACUUM-PRODUCER. Eugene A. Schenck, Kansas City, Kans.

1,108,248. SUCTION - CLEANER. George C. Schmitz, Racine, Wis.

1,108,275. VACUUM RENOVATING APPARATUS. Joseph H. Templin, Philadelphia, Pa.

1,108,280. FLUID - PRESSURE - BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,108,285. PNEUMATIC DRIER. John Moultrie Ward, Washington, D. C.

1,108,291. PNEUMATIC ENGINE-STARTER. Granville G. Westerfield, Indianapolis, Ind.

1,108,293. PNEUMATIC - DESPATCH - TUBE SELECTIVE SYSTEM. Frederick G. Whittier, Brookline, Mass.

1,108,334. APPARATUS FOR AERATING AND IRRIGATING SOIL. Lucian W. Carr, Crawfordsville, Ind.

1,108,342. MINE DRILLING AND CHANNELING MACHINE. Longfellow J. Daft, Seattle, Wash.

1,108,434. AIR COMPRESSOR OR PUMP. Venable J. Guthrie, Cambria, Va.

1,108,470. ELECTRIC PNEUMATIC - PRESSURE CONTROL. Edward K. Parker, Santa Barbara, Cal.

1,108,577. AUTOMATIC CAR-COUPLING WITH AIR-OPERATED RELEASE. Matt Himberger, Woodward, Iowa.

1,108,644. VACUUM-PRODUCING APPARATUS. Ferdinand A. Weimann, West Hoboken, N. J.

1,108,768. PNEUMATIC-CUSHION BOLSTER FOR VEHICLES. Joseph M. Lewis, Trenton, N. J.

1,108,834. PNEUMATIC HAMMER. Emmett G. Detrick, Vicksburg, Miss.

1,106,264. ATTACHMENT FOR TOOLS. Frank W. White, Brooklyn, N. Y.

1,106,332. PERCUSSIVE DRILL. John George Leyner, Denver, Colo.

1. In a fluid operated drill, a drill cylinder and a piston therein having a drill rod projecting forwardly thereof, said drill rod having a fluid conveying bore, a front head on said drill cylinder, a fluid pump cylinder secured to the front head, a piston in said fluid pump having a rod secured to said drill rod, and fluid connection for conveying fluid from said pump to said drill rod bore.

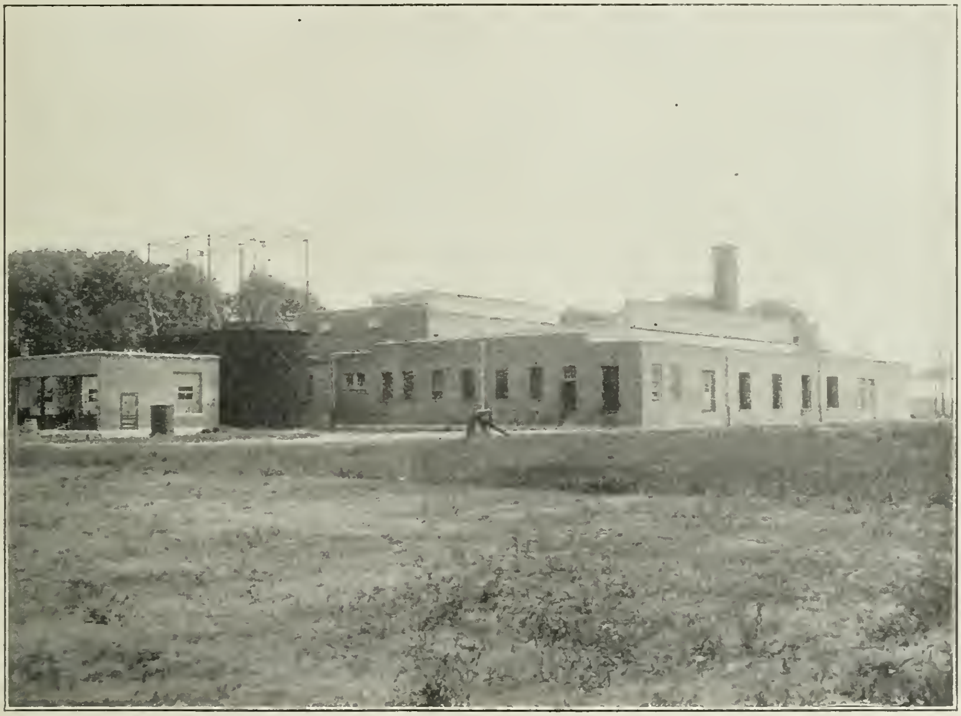
1,106,346. PNEUMATIC - DESPATCH - TUBE APPARATUS. Edmond A. Fordyce, Boston, Mass.

1,106,349. VACUUM CLEANING AND HEATING SYSTEM. Frank J. Matchette and Richard Raddatz, Milwaukee, Wis.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol XIX NOVEMBER, 1914 No. 11



PLANT OF THE LINDE AIR PRODUCTS COMPANY, ELIZABETH, N. J.

AIR "ON A TEAR"

BY FRANK RICHARDS.

Probably few realize the rapid growth and the present magnitude of the oxygen industry in the United States. The Linde Air Products Company has a dozen plants, located in different parts of the country for convenience of distribution, operated chiefly for the production of oxygen directly from the atmosphere, and the two views here given represent the "before and after" of one of these. The oxygen industry is not to be considered a dangerous one, and the company has never before had any such occurrence as it seems to come in the line of my duty here to describe. There were three fatalities in this case, and a rigid investigation was conducted by the local authorities, with the result that the Linde Company was exonerated from all blame in connection with the accident.

The plant shown in Fig. 1, known as No. 3, of the Linde establishments, was located at Linden, near Elizabeth, N. J., and on Saturday evening, Aug. 15, it was totally destroyed by fire and explosion, three being instantly killed, the engineer in charge, a workman or helper and the little son of the engineer, and three or four injured. Fig. 2 speaks for itself as to the completeness of the destruction. The building was fireproof except the roof, which was of slow burning construction and the office partitions and furniture.

There was a five-stage compressor delivering air up to 1800 lb. and three compressing pumps working up to a similar pressure for charging the tanks with oxygen for shipment. Electric power from an outside source was used entirely for driving. No oil was used in the compressor cylinders, and it and the pumps spoken of, with their pipes and appurtenances were found intact except as damaged by the fire and the falling of the roof. The oxygen produced was stored in the large gas holders seen in Fig. 1 until charged into the tanks. It is conceded by all that nothing thus far spoken of here requires any further consideration when seeking the cause of the catastrophe.

The Linde process consists essentially in the liquefaction of air by arrangements which have been frequently and sufficiently described, and then the separation of the nitrogen and the oxygen by the successive evaporation of each from the liquid. These operations, however, are not conducted separately, but more or less simultaneously and continuously with the liquefaction, and as a consequence the special apparatus employed, technically known as the "rectifier," is a very complicated affair, and the proper control and manipulation of it are among the most exacting of technical responsibilities.

In "Richards' Compressed Air Practice," recently published, the last chapter contains a diagrammatic sketch of a rectifier, and at the close of a condensed description it is remarked: "One may well wonder and inquire how the man in charge of the apparatus can keep himself informed as to all that is going on within it, throughout the series of operations, even when everything is going well; and especially how he can discover when things are going wrong or determine what he should do to right them." It would seem, as will appear later, that the engineer who was killed was in this conglomeration of perplexity when the catastrophe occurred.

WHAT CAUSED THE ACCIDENT?

As to the sequence of events in the development of this catastrophe no one seems to be quite clear. Indeed, it has not been decided whether there was first of all an explosion and then the fire, or whether fire, an actual ignition, was the beginning of it all. At the coroner's investigation the principal inquiry was as to how an igniting spark or flame could have been communicated to the explosive mixture or assemblage of combustible ingredients assumed to be present and which it would have been possible to fire in this way. There were no open lights, all the light being furnished by incandescent lamps with guarded bulbs.

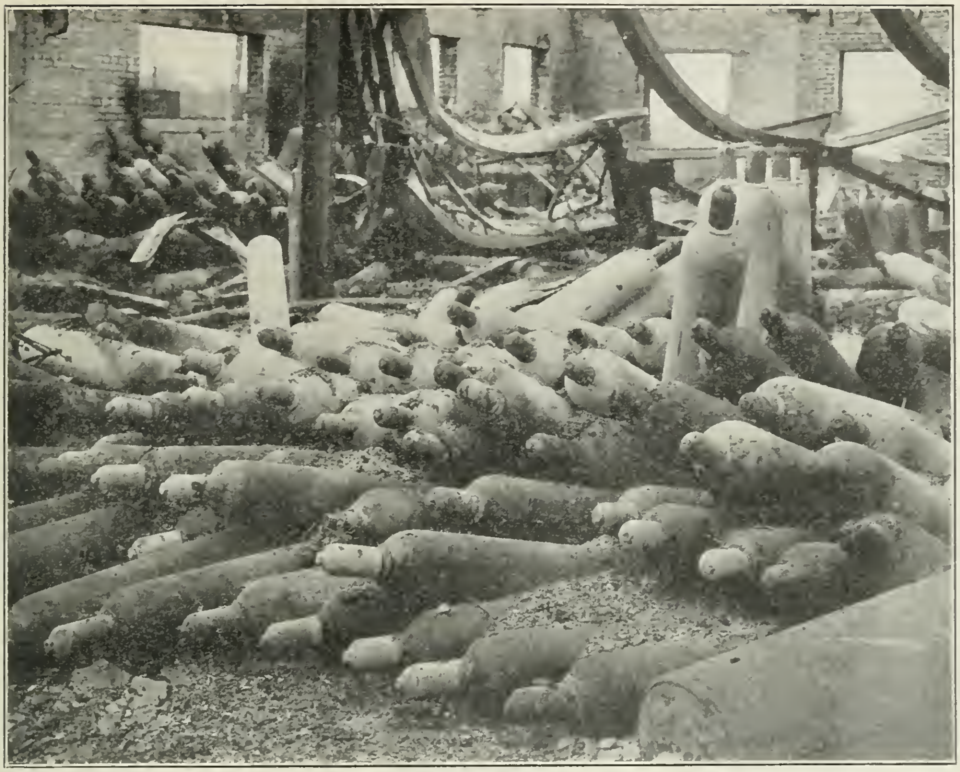
It it understood that while the representatives of the Linde Company candidly state that they are unable to explain the accident, their principal speculation also has been as to how fire could have been first communicated. This being so, it would seem to be quite in order, and more than desirable, that suggestions should be submitted, and what follows is nothing more than such a suggestion of a possible explanation.

LIQUID AIR PHENOMENA.

It is necessary for us to note in the first place how closely, in many of their characteristics, air and its liquid resemble steam and water. Both are readily convertible, or in fact change of themselves, from the liquid to the gaseous state, or vice versa, whenever the conditions of pressure and of temperature are right for such a change. There is no coaxing about the operation, the change being inevitable when the compelling conditions concur.

Water, as we all know, boils under atmospheric pressure at 212 degrees Fahr., and is changed to vapor as rapidly as the water can be brought to that temperature. To convert a considerable body of water into vapor sufficient heat must be artificially provided. To raise the boiling point of water it must be confined, and its vapor prevented from escaping, until the required temperature and the higher pressure are obtained. In the case of converting water into steam there is thus something to be actually done by us in providing the necessary increase of temperature.

With air the practical conditions are reversed. Air, the liquid, when under atmospheric pressure boils at—312 degrees, or 524



AFTER THE FIRE.

degrees below the boiling point of water. This temperature is so low that the great problem in handling liquid air for any purpose after it is produced is to keep its temperature down. If liquid air is confined and allowed merely to be heated by the absorption of heat from the container and its surroundings until it is up to normal atmospheric temperature the pressure will be about 12,000 lb. per sq. in., or say 100 times the gage pressure at which old steam boilers have been in the habit of exploding. Of course explosion would usually occur long before this high pressure was attained.

We happily do not know much from experience about liquid air explosions, because we know too well that the liquid must not be confined. It is worth while, however, to note the phenomena which might be expected to occur in the case of such an explosion. It would be quite analogous to the explosion of a steam boiler, except in one particular.

The difference in destructive effect between the explosion of an ordinary compressed air receiver and that of a steam boiler of comparable size and pressure has been often noted, the latter being always much the more violent. In the case of the air receiver there is nothing but the volume of air confined in the receiver to be reckoned with, even this air losing some of its explosive force by the fall of temperature in the act of expansion. With the steam boiler however, there is not only the actual body of confined steam to escape, but this is followed by mere steam instantly generated from the body of hot water, this continuing and following up the original body of steam until the temperature of the water has fallen to the normal atmospheric boiling point. In a boiler with any considerable water space only a portion of the water would thus flash into steam upon release of pressure, as its temperature would fall so rapidly in supplying the latent heat to the steam that might be generated. The entire operation would occur at temperatures above that of the atmosphere, so that the cooling of the water would be hastened and the generation of the follow-up steam would be thereby retarded and finally stopped.

In the case of an explosion of confined liquid air there would be not only the expansive force of the actual air in the upper portion of the containing vessel but there would be the same follow-up pressure from the air which instantly would boil away from the liquid, and all of the liquid would be very quickly vaporized, because the temperature of its surroundings would be so much higher than its boiling point. An explosion of confined air and its liquid should thus be expected to be more violent than an explosion of steam and water.

Supplementing the work of the air compressor, the apparatus employed for the liquefaction of the air and the separation of the two principal gases, the rectifier as it is technically called, is a very ingeniously complicated affair, its construction in detail and the processes employed in its manipulation being covered by patents in this and other countries, in addition to which experience and continued operation have added many valuable details, so that, very properly, the Linde Company do not reveal these things promiscuously, and we can only speak in a general way as to what happened in this case.

We know that the initial trouble was at the rectifier, as things were going wrong there. The compressor had been stopped and the engineer was making an investigation. The compressor supplied the air to the rectifier at a pressure from 1500 to 1800 lbs., this pressure being maintained in certain parts of the apparatus, while in other parts expansions occurred as an essential part of the operation. When in full operation there is quite a body of liquid air in process of supplementary treatment, and it goes without saying that intense cold prevailed within, there being large masses of wool packed between an inner and an outer shell, its function in this case being to keep heat out instead of keeping it in, which would have been the use of it with which we are more familiar.

A door of the outer shell was removed, the wool inside was pulled out and then the door of the inner shell was taken off, the effect of this, remembering the liquid air within, being equivalent to the firing up of a steam boiler. An investigation of the interior was now attempted. The moisture in the immediately surrounding air was condensed, causing a thick fog, and the first man to look in quickly gave it up on account of the cold. Then the engineer tried it, he apparently reaching farther in, so that he exclaimed "I think I've found the leak," and immediately the catastrophe occurred. Besides the three who were killed, two men were thrown out through the windows, and they with two or three others in remoter parts of the building were so stunned that no one can tell anything further as to what happened.

The explosion and the beginning of the fire, so far as appears, were practically simultaneous. If there was first an explosion of the confined liquid air subject to abnormal pressure by accidental stoppage of passages, by a mistake in the manipulation of stop valves, or by the failure of pressure releasing devices, such an explosion, accompanied by the breaking of incandescent lamp bulbs, might easily account for the fire, as ignitions from this cause are a well known possibility in the gaseous atmosphere of coal mines.

The destruction of the building by fire was apparently as complete as was ever recorded. The fire was undoubtedly intensified by the oxygen released from the great number of charged tanks, all of which were emptied while the fire was in progress. These tanks had different ways of discharging their contents when exposed to the heat. There were 123 low pressure tanks or cylinders of an old type used by another company and now being discarded. These were charged to a pressure of only 300 lbs. but 5 of these cylinders opened at the sides and 22 had their brazed heads blown out. There were also 4 high pressure 50 ft. cylinders of German make belonging to customers which also let go. The metal of all the cylinders which gave out was excellent and without brittleness, so that there were no detached pieces thrown off in any case.

THE SAFETY TANKS.

Notwithstanding the severe loss sustained by the company there is a large compensation in the revelation of the absolute safety of the high pressure tanks now employed by the company and sent out by them all over the country. Probably no severer test of them could have been devised. There were in the building 792 of these high pressure tanks, such as seen in Fig. 2, charged to 1800 lbs. and not one of these exploded, although all of them when heated discharged their contents and were relieved of all pressure.

The safety device employed is simple enough. There is a fusible plug supporting a copper disc. The plug melts at a precisely determined temperature, which is not high, and this melting removes the support from the copper disc and the contents of the tank are immediately released. This safety device did not fail to operate in any one of the 792 cylinders exposed to the intense and sudden heat.

Although the destruction of the plant was so complete it is being built again with great rapidity, so that it is expected that operations will be resumed by Dec. 1, which indicates, by the way, what a demand there is for the product.

COMPRESSED AIR FOR ORE FLOTATION

New methods of accomplishing ore flotation are being rapidly developed, and a wide variety of means used to accomplish the purpose. One of the most interesting as well as successful methods is that of using air as the agitating and froth-producing medium. Plants using this method have been installed by the General Engineering Co., of Salt Lake City, Utah, at the National mill, in Idaho, the Magma, Miami and Inspiration in Arizona. The ore is mixed with oil and water and fed into a separator which consists of a rectangular cell having an inclined false bottom covered with fabric. Compressed air admitted into compartments below the false bottom passes upward through the fabric and is divided into innumerable small bubbles which form a froth 12 to 18 inches deep in the cell. Mineral concentrate rises with this froth and overflows the sides of the cell, while gangue flows down the inclined bottom and is discharged. If desired, the first cell can be used as a rough concentrator, and the valuable product re-treated in another cell. The products from several roughers could be combined on one cleaner. Pine oil has been found to be a good floating medium, and is used in the oil mixture in varying proportions.—*Metallurgical and Chemical Engineering.*

AUTOMOBILE SPEED RECORD—WIND RESISTANCE

On August 12th, Teddy Tetzlaff in a Blitzen-Benz automobile, raced over the Salt Beds at Saduro, Utah, on the Western Pacific Railway, 112 miles west of Salt Lake City, at a speed of 142.85 miles per hour, or 2.38 miles per minute. This speed was attained in demonstrating the theory that these remarkable beds of salt offer the fastest course in the world. These salt beds 65 miles long and 8 miles wide, and, except for the railroad crossing them, are without obstruction of any kind. The speed is believed to be the greatest ever attained by man and can only be accounted for by the non-resistance and the low temperature of the crystallized salt, which forms a hard and absolutely level surface and one which even in the hottest weather does not heat the tires.

For speed records there is, besides the condition of the road surface, the resistance of the atmosphere to be reckoned with, and at such unheard of speeds as the above this resistance may be greatest of the obstacles to be overcome, and the one which must eventually determine the ultimate limit.

The simplified formula of the U. S. Weather Bureau for computing wind pressures against perpendicular area 1 foot square, with barometer at 30 inches, is $0.004V^2$, V being the velocity in miles per hour. In the case above $.004(142.85^2) = 41.624$ lb. per sq. ft., and if we assume the auto to present an effective resistance area of only 8 sq. ft. the total resistance would be $41.624 \times 8 = 333$ lb. The speed attained, 2.38 miles per min.=12566 ft. per min., and this multiplied by 333=4184478 ft. pds. per min., and this divided by 33,000=126.8 horse power.

INFLAMMATION LIMITS OF GASEOUS MIXTURES

It is interesting to note that British investigators have proved conclusively that minute sparks can be passed through an explosive gaseous mixture without exploding it, although the temperature of the spark is above the generally accepted ignition temperature of the mixture. It was observed, however, that some slight combustion took place in the path of the spark. When the intensity of the spark was increased, the gases exploded.

These experiments would seem to indicate that gas mixtures differ considerably in their ignition temperature. In other words, a gaseous mixture diluted with inert gas, or under reduced pressure, requires a hotter spark to fire it than when it exists under normal conditions. Methane (the chief constituent of firedamp) differs from hydrogen in having a higher ignition temperature and a more prolonged process of oxidation for complete combustion. It is for this reason, in all probability, that in the case of an inflammable mixture containing methane, the source of heat necessary to inflame the mixture must be more intense and must be longer in contact with it than in the case of a hydrogen mixture.—*Coal Age.*

THE LEYNER MACHINE FOR DRIFT ROUNDS

BY CHARLES A. HIRSCHBERG.

Economical mining and tunneling calls for the breaking of the most ground with the least footage of holes, inasmuch as this means a saving of powder, time, labor, materials and power. To accomplish this, a thorough knowledge is necessary of the character of the ground to be drilled and broken, its hardness and stratification, whether damp or dry and whether likely to cave or not. Drill steel properly gaged and bitted must be provided, and drilling machines that are economical of power, easily maintained, quickly handled and capable of rapid drilling. Some types of machine drills, while having a large capacity for work when no limitations are imposed as to location, size and depth of holes, cannot always be utilized for drilling the most effective round of holes, due to various features of design to be enlarged upon later.

These features cannot be categorized with faulty design, in the true sense, but rather should be considered as limitations that render an otherwise efficient machine unsuitable for certain rounds of holes calling for drilling close to the top or side walls and at a slight pitch; such machines require ample head and wall room for operation; consequently they are slow in operation and hard to handle.

These drills are of the piston or reciprocating type, as distinguished from the hammer drill. Although all hard-rock drills are reciprocating machines, strictly speaking, the term is best applied to that type in which the steel is rigidly fastened to the front end of the piston and reciprocates back and forth with it, while the term "hammer" is applied to that type in which the steel is inserted loosely in the front end of the machine and is struck by the piston.

The hammer drill divides itself into several styles as distinguished by the method of application to the rock. First, the mounted type, of which the Leyner is an example; second, the self-supporting and automatic air-feed type, commonly called a stoper; and third, the held-in-the-hand plugger or sinker type.

It is the purpose of this paper to deal more particularly with the mounted-hammer type in describing drilling rounds for different characters of ground, and it will be brought out that reciprocating drills are restricted in their application to certain drilling rounds, and hammer drills, on the contrary, are readily applicable to the drilling of all kinds of rounds. It is between these two types alone that a true comparison can be made, inasmuch as both are applied to similar work, such as drifting or tunneling, whereas the stoper and the plugger only rarely come into competition with the mounted machines.

THE LEYNER CUT.

Fig. 1 shows a round of holes, to which the term "Leyner cut" has been applied, used in a drift or tunnel where the rock is extremely hard. It has been used with variations in the mines of Arizona, Colorado and Michigan. It involves a pyramid or center cut including a great many upper or dry holes.

The advantages of the Leyner cut are: (1) The holes are drilled with as few changes ot machines and set-ups as possible; (2) a pyramid-shaped wedge of rock is first pulled from the center, after which the rest of the round breaks readily While there is no hard-and-fast method of putting in such a round of holes, the principle is the same in all cases and involves the many upper and dry holes shown in the illustration.

It is particularly suitable for solid formations containing no slips or seams to break to. It has been used with marked success in the hard rock and ore of northern Michigan, and in at least one case has resulted in drifting at nearly four times the speed formerly made with piston machines. The object of the cut and the system of putting in the holes have been found capable of easy explanation to the foreign miners, so that in a short time they were taught to use this round successfully and almost automatically.

Referring to the illustration. *C* designates the position of the crank of the drill in each case. *A* is a cross-bar in the first position. From the top of the bar the four back holes. Nos. 9, 10, 11 and 12, are drilled. The machine is then "dumped" or tipped forward until the crank can just turn and clear the back or top of the drift, is moved out a little on the bar and the top centercut holes 1 and 2 are drilled. If the bar is set up correctly in a drift of the size shown, the machine can be dumped enough to reach the center of the drift heading with the bottom of the hole. The machine is then turned under the bar and the side holes 7 and 8 and the cut holes 5 and 6 are drilled.

The crossbar is next dropped to position *B*, the machine is set up on top and the side holes

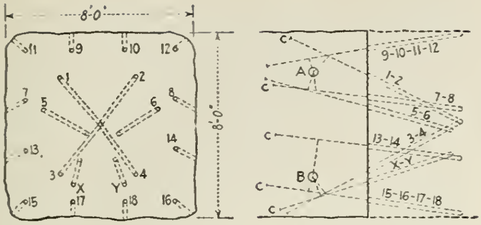


FIG. 1

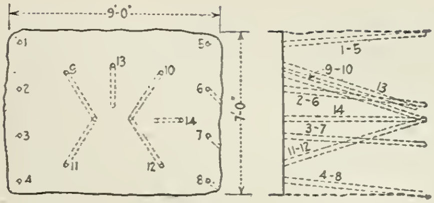
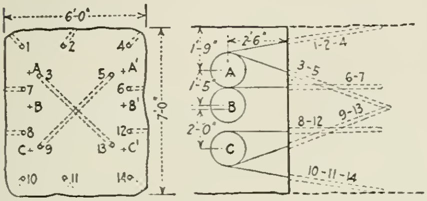


FIG. 3.



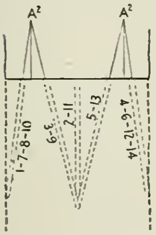


FIG. 2

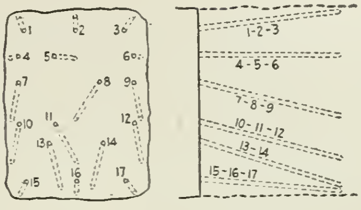


FIG. 4.

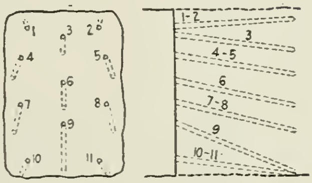


FIG. 5.

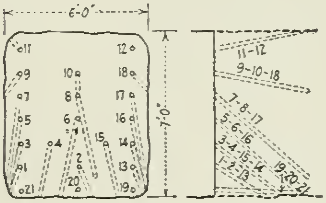
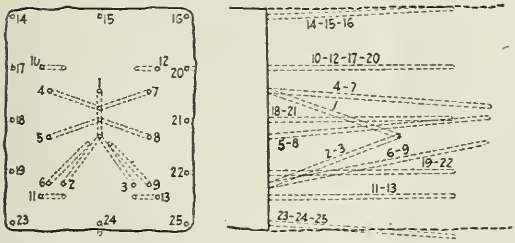


FIG. 8.



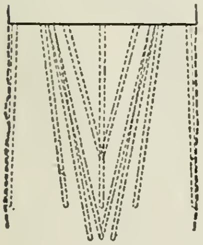


FIG. 6.

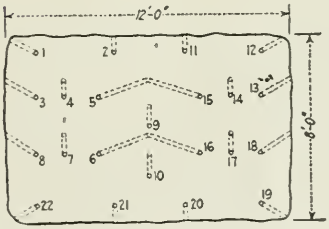


FIG. 9.

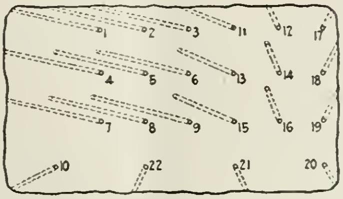


FIG. 7.

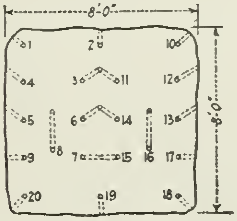


FIG. 10.

VARIOUS LAYOUTS OF HOLES WITH LEYNER DRILL.

13 and 14 drilled. Finally, the machines are turned under the bar, tipped up in front so that the crank just clears the bottom of the drift and holes 3 and 4 are drilled so as about to meet Nos. 1 and 2 in the center of the heading. The four lifters, 15, 16, 17 and 18 are drilled last, except that, if there is time enough, relievers something like *X* and *Y* may be put in to make sure. When sufficiently strong explosive is used, however, the round will break without these last.

Some of the holes could be placed to better advantage, perhaps if there were time for another "set-up," or if a column could be used, but this particular sketch applies to a place where it was necessary to drill 100 ft. with two machines in extremely hard steel-ore and jasper and there was no time to waste.

The full round shown in the illustration is designed for hard rock, but a modified round of this kind could be used almost anywhere. In softer and better breaking ground, cut holes 5 and 6, relievers *X* and *Y*, one lifter and one back hole can be left out, but the four cut-holes 1, 2, 3 and 4 are nearly always used and are pitched up or down, and in, to meet about at the center.

There are two reasons why this round is practically impossible with piston drills. First, they cannot drill it fast enough, particularly on account of the dry holes; and second, the size of the piston drill is too great to permit operating it in the positions necessary to give the holes the proper pitch and angle.

Fig. 2 shows another pyramid cut as used in some of the mines of Mexico for driving small drifts in hard rock. This round is drilled from an arm mounted on a column, *A* and *C*, A^1 and C^1 representing the vertical positions of the arm, and A^2 the horizontal position of the arm and drill on both sides of the column; the column is placed midway between the walls of the drift. Holes 4 and 5 are first drilled from the top of the arm, on the right-hand set-up. The drill is then swung under the arm and hole 6 put in. Next the arm is swung to the left-hand side of the column and hole 7 drilled. The machine is turned to the top of the arm and holes 1, 2 and 3 are drilled. The arm and drill are then dropped to *C* and hole 8 drilled; the machine is swung under and 9, 10 and 11 put in. Holes 13 and 14 are drilled by swinging the arm and drill to the right of the column with the machine underneath. The machine is turned on top of the arm and hole 12 drilled, which completes the round.

A SOUTH AFRICAN ROUND.

Fig. 3 shows a round of holes employed in the mines of South Africa in a drift 9 ft. wide by 7 ft. high. It usually comprises 12 holes. Hole No. 13 is sometimes drilled when the rock is not breaking properly, while both 13 and 14 are used when extremely hard rock is encountered.

For extremely hard ground extra holes may be drilled with the arm and machine at *B*, but in all moderately hard rock this has not been found necessary.

The distance between holes 1, 2, 3 and 4 in the vertical line is approximately 2 ft., likewise the distance between holes Nos. 5, 6, 7 and 8. Holes 9, 10, 11 and 12, or, in other words, the cut holes, are put in approximately 4 ft. apart at the face of the rock, but holes 9 and 10 slant downward and inward and meet holes 11 and 12, which slant upward and inward. The distance between the junction of holes 9 and 11, and 10 and 12, at the bottom, is approximately 18 in. Hole 13, when used, is put in 1½ ft. below the top of the drift and slanting downward until it comes to about a central point 18 in. from the junction of holes 9 and 11 and from that of 10 and 12.

Hole No. 14, when used, is put in at the face, about 2 ft. 6 in. from the center of the cut, and slants in as shown, to a distance of about 18 in. from the junction of holes 10 and 12. Usually, however, holes Nos. 13 and 14 are not used. The round of 12 holes generally breaks between 5½ and 6 ft. of ground. The machine is mounted on a column and arm.

CRIPPLE CREEK ROUNDS.

Fig. 4 shows a hammer-drill round used in the Cripple Creek district of Colorado. It consists of 17 holes and is used only in drifts 8 ft. high by 6 ft. wide or larger, where the rock is an exceedingly hard phonolite. It will be noted that with the exception of the back holes 1, 2 and 3, all the holes point downward. This round will break between 5 and 6 ft. of ground.

Fig 5 shows the round of Fig. 4, modified for a smaller drift, one 7 ft. high and 5 ft. wide. It consists of but 11 holes and is used for drilling in brecciated formation and in vein matter.

The ordinary double-screw column with one set-up is used for both rounds. Of course, the arm is shifted from side to side and lowered as occasion requires, the holes being drilled from both above and below the arm.

These rounds are varied slightly with the nature of the ground; fewer holes are sometimes drilled, but never more.

THE LUCANIA TUNNEL.

Fig. 6 illustrates a round used several years ago in driving the Lucania tunnel at Idaho Springs, Colo., put in with Leyner machines. This tunnel is 9 ft. 6 in. high by 8 ft. wide, and the advance averaged between 7 ft. 6 in. and 8 ft. per round.

The set-up involved the use of two columns, one carrying two arms and the other one arm, making a total of three machines. Short cut-holes 1, 2 and 3 were drilled 6 ft. deep; long cut-holes 4, 5, 6, 7, 8 and 9, 9 ft. 6 in. deep; relievers 10, 11, 12 and 13, 8 ft. deep; back holes 14, 15 and 16, 8 ft. deep; side holes 17, 18, 19, 20, 21 and 22, 8 ft. deep; lifters 23, 24 and 25, 8 ft. deep. Holes 6, 2, 3, 9, 11, 13, 23, 24 and 25 were drilled by the bottom machine; the rest were drilled by the two top machines. The round was shot in the order numbered, the two cuts being loaded and fired first. The balance of the round was then loaded and fired.

During 1911, when the tunnel was being driven on contract by Claypole & Hauser, the work was remarkable for rapid progress and low costs. During June of that year a careful record was kept of all expenditures, and it was found that the tunnel was being driven its entire cross-section for $15.93 per ft. This figure included everything but depreciation on the power plant, *i.e.*, compressor and blower, which was furnished by the Lucania Co.

The figures for the month of June follow:

JUNE PERFORMANCE AT THE LUCANIA TUNNEL

Nature of ground—hard pegmatite.
Total progress—232.5 ft.
Number of shifts—30 eight-hour shifts.
Advance per shift—7.75 ft.
Drill labor—3 runners and 2 helpers.
Outside labor—1 trammer, 1 trackman, 1 blacksmith and 1 day and 1 night engineer.
Mucking—contracted at $2.65 per linear ft.
Machines used—three water Leyner drills.
Depth of holes—6 ft., 8 ft. and 9½ ft.
Powder—1¼x8-in. du Pont 50% Repauno, German ZL fuse and 6X du Pont caps
Outside equipment—Leyner 480-ft. belted air compressor, Leyner drill sharpener and Connersville blower.

COST DISTRIBUTION

Classification	Labor	Live Stock	Material and Supplies	Freight and Handling	Total	Per Ft.
Superintending	$150.00				$150.00	$0.6451
Engineers	240.00				240.00	1.0322
Excavation[1]	480.00		$1056.61	$43.21	1579.82	6.7949
Day tramming[2]	105.00	$12.75			117.75	0.5064
Track	105.00		11.87	0.49	117.36	0.5048
Blacksmith	150.00		16.80	0.70	167.50	0.7204
Mucking					616.12	2.6499
Power					515.86	2.2187
Lighting			14.85	0.60	15.45	0.0664
Drill repairs					21.30	0.0916
Miscellaneous supplies			159.40	5.08	164.48	0.7074
Totals	$1230.00	$12.75	$1259.53	$50.08	$3705.64	$15.93+

[1] Includes all steel received to that date.

[2] For handling supplies, etc., owing to the mucking being done on subcontract.

COST RECAPITULATION

Classification	Total	Per Ft.
Labor	$1230.00	$5.2903
Live stock	12.75	0.0548
Material and supplies	1259.53	5.4137
Drill repairs	21.30	0.0916
Freight and handling	50.08	0.2137
Mucking	616.12	2.6499
Power	515.86	2.2187
Total	$3705.64	$15.93+

MICHIGAN COPPER ROUNDS.

Fig. 7 exhibits a round employed in the Michigan copper country for what is known as drift stope, the width of which varies according to the width of the lode; the object is to take out all of the rock between the foot and hanging walls, the holes being pointed in some cases toward the foot and in others toward the hanging. The round as illustrated would do for an 8x14-ft. drift. The set-up consists of a double-screw column with arm.

Fig. 8 shows the method in use at the Quincy mine for small drifts; it works satisfactorily in this particular case owing to the fact that driving is done entirely through trap, there being no copper to contend with. This round is not good, however, in ground that is heavily charged with copper, since great difficulty would be encountered in getting the cuttings out of the holes. In such cases the direction of the holes should be reversed so as to point upwards. The round is shown for a 6x7-ft. drift and is drilled from a column with arm.

The holes are drilled to the following depths: 1, 2 and 3, 2 ft. 6 in. deep; 3. 4, 14 and 15, 3 ft. 6 in. deep; 19, 20 and 21, 4 ft. deep; 5, 6 and 16, 4 ft. 6 in. deep; 9, 10, 11, 12 and 18, 5 ft. 8 in. deep; 7, 8 and 17, 6 ft. deep.

MICHIGAN IRON ROUNDS.

In Fig. 9 is shown a round of holes for an 8x12-ft. drift as used in the Dober mine near Iron River. The ground was a gray slate. The holes were drilled from a column and arm and required two set-ups, owing to the wideness of the drift. All holes were drilled to a depth of 5 ft. with the exception of those numbered 5, 6, 15 and 16, which were drilled 5 ft. 6 in. deep.

Fig. 10 shows a round of holes employed in medium-hard iron ore at the Cary mine, Hurley, Wis. The size of the drift is 8x8 ft.

All holes with the exception of 18, 19 and 20 look up a little above the horizontal. Holes 1, 2, 4, 5, 9, 10, 12, 13 and 17 are drilled 5 ft. deep; 18, 19 and 20, 5 ft. 6 in. deep; 3, 6, 7, 11, 14 and 15, 5 ft. 8 in. deep; 8 and 16, 6 ft. 6 in. deep. This cut breaks well and lengthens the drift 4½ ft. with each round. The round is drilled with column and arm set-up.

THE ROOSEVELT TUNNEL.

The Roosevelt drainage tunnel at Cripple Creek, Colo., is believed to have been about the hardest tunnel driving ever encountered. Three sets of contractors successively undertook the job and failed. The rock is that designated by the government geologists as Pike's Peak granite. In some parts the rock has a gneissic or schistose structure, but in the main it is characterized and made notorious by the lack of seams or joints. Thus, while the rock itself is hard, the lack of lines of fracture and planes of seaming is doubtless responsible for the poor rate of progress made by the first contractors. The tunnel was started 10 ft. high and 7 ft. wide, but in the final contract this was changed to 10 ft. wide by 6 ft. high over the rails, and a 3x6-ft. drainage ditch was added.

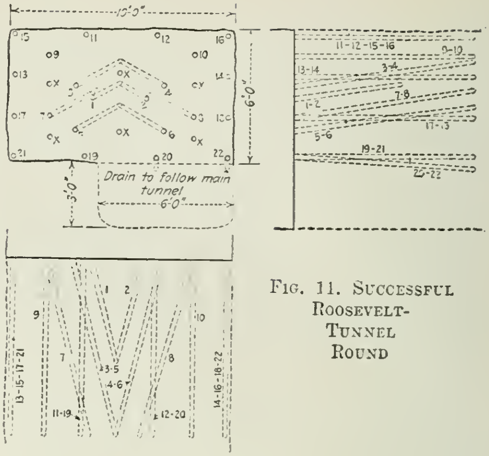


FIG. 11. SUCCESSFUL ROOSEVELT-TUNNEL ROUND

After the trial of several systems of placing the drill holes, that shown in Fig. 11 finally proved to be best adapted to the tough nature of the jointless rock. Water-Leyner drills were employed. In attacking the ordinary rock, all holes were drilled 8 ft. except the cuts and relief cuts, Nos. 1 to 8, inclusive, which were drilled to a 10-ft. depth. In tougher ground, these depths were each cut down 2 ft., and in addition to the 22 holes used on the ordinary rock and numbered in Fig. 11. the six extra holes *X* were put in.

At first, even with the use of from 300 to 350 lb. of 60 per cent. dynamite, great difficulty was experienced in properly blasting the eight cut-holes, sometimes several loadings being necessary to blow out the cut. Finally, however, after putting in the two extra cuts shown, even the toughest ground yielded. The system of placing the holes was evolved with a view not only to blasting the rock to the best advantage, but also to allow the greatest economy of time in drilling. These ends proved to be best effected by mounting the two Leyner drills on a single, horizontal crossbar, instead of on the more usual two independent vertical columns. In this way even the maximum number of 28 holes required but two set-ups of the bar. It will be readily understood that this way of placing the bar eliminated the necessity of mucking out of the bottom before starting drilling, as when vertical columns are used.

The grade line was carried about 18 in. below the top of the bore and about 8 to 12 in. below this was placed the bar. From this, the center and corner back-holes were drilled, and then by revolving the drill around and beneath the supporting bar, all of the remaining holes except the center lifters and bottom corners were put in.

It will be understood that the difference in the level of the drill bit between its position on top of the bar, and below the bar, amounted to about 2 ft. By using proper judgment in placing the horizontal bar, therefore, the feat of putting in 18 holes from one set-up was easily accomplished. The bar was then shifted to its second position, usually about 18 to 24 in. above the floor, and the last four holes put in. In tough ground an extra center-cut hole *X* was also put in from this set-up.

The bits used at the start of a hole were 3 ft. in length, with a diameter of 2¾ in. Each succeeding steel was 2 ft. longer than the one before, the 11-ft. cut holes requiring six steels to a hole, while the others required five steels each. The diameter of the hole bottom averaged about 1½ in. The number of steels was carefully determined so that as fast as one became dulled it was replaced by a sharp one. While this may seem a minor point, experience proved it to be a potent factor in influencing the speed of drilling and increasing the rate of progress made in driving the tunnel.

The ditch was kept back of the breast about 150 ft. and taken out at convenient intervals by placing vertical 3-ft. holes spaced on 2-ft. centers along the intended center line of the ditch, an ordinary tripod being employed for this work.

THE LARAMIE-POUDRE TUNNEL.

The Laramie-Poudre tunnel at the beginning of the year 1911 held the best two American tunnel-driving records: 609 ft. in January, 1911, and 653 ft. in March. Fig. 12 shows the layout of the holes in regular work. The holes were drilled and shot in the succession numbered in the cut, requiring two set-ups of the tunnel bar, no column being used. The upper set-up was drilled on top of the muck pile, and in the meantime the muck was cleared away, when the bar was lowered and the lifters put in. Holes were started 2⅛ in. in diameter and bottomed at 1⅜ in.

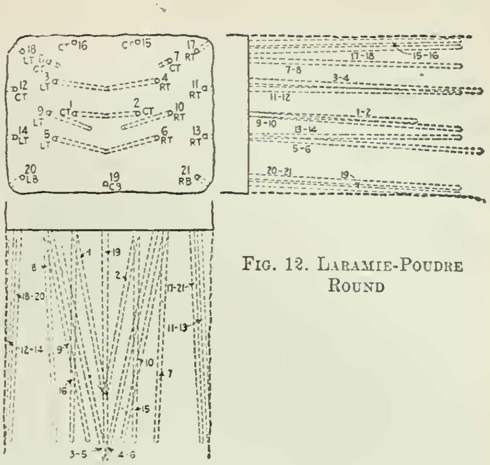


FIG. 12. LARAMIE-POUDRE ROUND

Two water Leyner machines were used, drilling 10-ft. and 12-ft. holes. In case of extremely hard rock a third machine was mounted, each machine drilling holes as follows: Those lettered *LT* were drilled by the left-hand machine on the top set-up, those marked *CT* by the center machine on the top set-up, and those marked *RT* by the hight-hand machine on the top set-up. The bar was then lowered and each machine put in a lifter, lettered *LB, CB* and *RB*. The blasting charge for a round generally consisted of about 100 sticks of 100% gelatin, 150 sticks of 60% and 250 sticks of 50%.—*Eng. and Min. Journal.*

CHEAP GAS

The Widnes Corporation, of England, which for years has held the proud position of purveyor of "the cheapest gas in the world," has further strengthened that position by making another reduction in price. The last reduction cuts the price to consumers within the borough 2 cents per 1,000 cu. ft., making its price to consumers below 3,000,000 cu. ft. per annum, 24 cents net per 1,000, to consumers over 3,000,000, 20 cents net, and to all users of gas for motive-power purposes, 16 cents net. This cut was made possible by the improved carbonization resulting from a new installation of horizontal retorts which will make Widnes gas from 20 per cent. to 27 per cent. cheaper in price than that of its nearest competitor, the Sheffield Gas Co. Only recently was celebrated the inauguration of a new carbonizing plant which cost the city about $200,000, but which will decrease the cost of production, while largely increasing its output.—*Gas Age.*

AIR COMPRESSOR EXPERIENCE CAULKING LEAD WOOL JOINTS

BY DANIEL J. HIGGINS.*

My first knowledge of the Air Compressor was some twenty years ago, and at that time the term Air Compressor loomed up mighty big to me. I was then a pattern maker and an air compressor was to be built for the famous firm of Engineers, Westinghouse, Church, Kerr and Company. It was considered quite a thing to make the set of water jacket cores which surround the air cylinder for cooling. This machine was manufactured, finished up, and, if I recall correctly, a test was made and the first casting of the compressor end was found to be porous, air being forced through the iron.

From that time on, air compressors have crossed my path in many ways. I have had four years experience in the United States Navy, and the wonderful work that the air compressor performed in marine work was most notable. The compressor plant is located in any available place, and is so arranged that, with the hose connection, it can transmit power to drive tools in isolated places. In marine work, especially in the work of drilling, riveting and caulking the steel sides of our battleships, it is a very wonderful invention. To-day a very light tool in the hands of a skilled man does a phenomenal amount of work as compared with the amount done with hand tools.

You have but to observe, those of us who have opportunity of being in large cities, the start of a sky-scraper building. The structural steel comes in the "knock-down" from points in Pennsylvania, is landed in Boston, New York, Chicago or San Francisco, and, with just the aid of the crane or derrick, the pieces are put in place. We find the riveter with his air tools following the setting of the frame of the building, and, before long, we have any number of stories securely knit together.

Where would the structural iron workers be without the Air Compressor? It is true they are a very capable class of men while working in gangs, but this cuts the gangs down several men. A gang usually consists of the butter up, two riveters and the heater boy. With the aid of the Air Compressor, all that is needed now is the butter up and one riveter. This decreace of expense seems small, but figured on a large job it amounts to quite a sum in dollars and cents, besides the saving in time.

In machine tool work, we find many instances where the air compressor is brought into play. Foundry work to-day is greatly aided by an air compressor. Having an Air Compressor in a foundry plant, we find all our castings sand blasted and also moulding machines run with air. After the casting is made and cleaned, we see an air tool used on the snagging of the casting.

CAULKING LEAD WOOL JOINTS.

Last year, we had occasion to lay about ten thousand feet of 10-inch pipe. After making the necessary plans and estimates, I happened to get in touch with a manufacturer of air compressors, and there were some things in the small machine he offered which appealed to me for caulking lead joints. The main features were that it was portable, not too heavy and with enough power to run the caulking hammer comfortably. The whole outfit cost less than $450.00, and showed in the end that this job almost paid for the machine. The first cuts which were shown me did not appeal to me particularly, as they showed a wooden bed. I took up the matter with the manufacturer and asked to have this machine made on a channel-iron bed. This was done, and since that time, all machines are made with channel-iron beds. They made certain claims for the wooden bed, but after having our channel-iron bed under severe usage, I was convinced it was the proper thing.

The machine which we purchased was directly connected with a single cylinder, four cycle gasoline engine to the air compressor, pumping directly into a vertical tank placed on the same bed. On top of the tank was arranged a safety valve and also an air valve. Beyond the air valve was a slip joint and lock coupling for air hose. We had fifty feet of hose and after placing the machine on the street side of the ditch, opposite the side where the gravel was to be thrown out, we found that by placing the machine at any point 50 feet from where we started, we could caulk 100 feet without moving the machine: That is, we ran 50 feet back of the machine and

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*Superintendent Water Department, Waltham, Mass. Paper read at Boston meeting New England Water Works Association, Sept., 1914.

LEAD WOOL CAULKING ON BIG WATER MAIN.

then 50 feet ahead. This put in practically eight joints.

In one 5000 foot section, we ran across about 1000 feet of ledge and rather than call in a contractor, or drilling the ledge out by hand, I decided to buy an air drill. This cost about $68.00 with a set of drills, and we removed 1000 feet of ledge. We found this was a very good investment as we have used the machine many times since then for removing ledge and have also found it profitable to transport it to various points in the city to remove large boulders when we ran across them in the trenches.

Now, as to caulking, we used the best Omaha lead and, instead of a straight bell, we used a beveled one, because it was necessary to have more lead protruding slightly beyond the bell end when caulking with the machine. This would seem to indicate that the lead was more firmly forced into the joint, and we have never split a bell. The length of time necessary to caulk a joint was nominally about three minutes to the joint, as compared with fifteen minutes under former conditions. Our first caulking tools were made a trifle long, and after experimenting with them we decided that a short tool was more practicable.

At first our caulking gang was a bit timid in using the machine. They were under the impression it was going to cheat them out of a job, but after a few demonstrations they realized the machine was a powerful aid to them, and later realized the wonderful power behind the blow of the air hammer. We found that under-side caulking was made much easier, on account of the hard position and reaching that caulkers had to assume in order to do satisfactory work under old conditions. The machine works just as well underneath as on the sides and top, where access is much easier.

In my first crew was a fairly intelligent man to run the machine and also to lend a hand in setting the pipe. I found at first that this fairly intelligent man was addicted to the very serious habit of using a screw driver and monkey wrench on the machine, and would not do as he was told. This lasted several days and we finally had to let him go. A high school boy, formerly water-boy for the gang, was taken and put running the machine with the same instructions as given the former man. He proved a wonderful success, followed instructions to the letter and we had much better results than at first.

The portable air compressor differs from all other plants of this kind. The engine and the compressor are combined in one machine. The air piston is connected on the same crank shaft as the engine piston, making what is known as a double throw method, which gives absolutely the same speed and power to the compressor as the engine. Another improvement is the piston discharge valve instead of the old style stem-valve, which makes it possible to reduce the valve space behind the air piston to a minimum. This valve also increases the efficiency about fifteen per cent. and is practically indestructible. The compressor is also equipped with an unloader which automatically relieves the compressor at any desired pressure up to 125 pounds. The engine is equipped with a magneto which makes the use of batteries unnecessary. The gasoline supply is retained in the base of the engine.

The requirements of a properly caulked joint involve a rather tedious and slow operation when performed by hand. In addition it is expensive and lacks uniformity and reliability. This is most noticeable on the under side of a joint, due to its inaccessibility. The pneumatic hammer gives an absolutely uniform joint on top and bottom.

The specifications of the Compressor are as follows:

Engine—5 H. P.: hopper water cooled.

Compessor—4½x6 in. air cooled.

Capacity—23 cu. ft. free air per minute.

Size of air tank—20x60 in. or 30x60 in.

Total weight—With 20 in. tank 1650 lbs., with 30 in. tank, 1800 lbs.

Total length—6 ft.

Total width—34 in.

Pneumatic tool capacity—With 20x60 in. tank, 1 Pneumatic caulking tool or 1 Pneumatic rock drill; with 30x60 in. tank, 2 Pneumatic caulking tools or 1 rock drill.

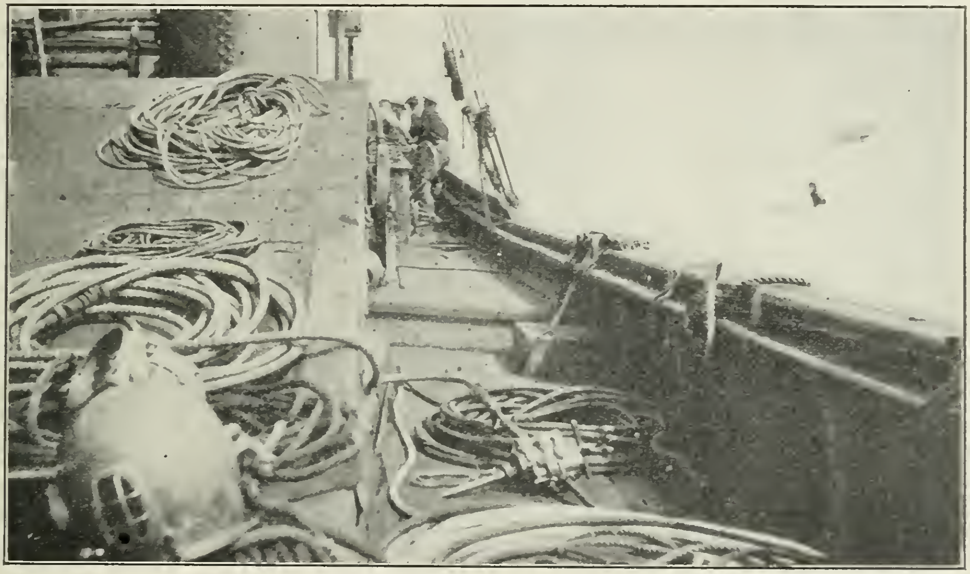
The cost of the outfit was $436.60, complete, with a caulking hammer for caulking pipe, cutting or chipping bricks or concrete, a set of 6 steels, and air hose in 50 ft. lengths. We bought an Imperiar Air Hammer for rock drill work.

In conclusion, I would state that we are firmly of the opinion that the air compressor for caulking lead joints and for rock drilling has passed the experimental stage in water works construction and I would heartily recommend it to any superintendent or engineer for this sort of work.

WORK ON THE ARROWROCK DAM

Foundation work for the highest dam in the world is an important part of the structure. The bedrock foundation of the dam lies 80 or 90 feet below the present bed of the river, although it was the original bed of the channel. It is a hard granite, somewhat seamy, but without open continuous seams. Being firm, rough and irregular, this rock is considered ideal for foundation conditions. All the excavation in the river bed, some 250,000 cubic yards, was completed by April first of this year, and the dam itself had been carried to a height of 140 feet, out of its total of 350 feet. More than 200,000 cubic yards of concrete had been placed in the dam, equal to about 36 per cent. of the estimated total. Concrete for the dam proper is mixed about 1 part sand-cement, 2½ parts sand, 5½ parts gravel and 3 parts cobbles; but for a thickness of 5 to 10 feet against each face a richer mix is used. There are three mixer units at the plant, two being in use for two 8-hour shifts, six days in the week, and the third being reserved as an emergency unit. Cableways lead from the mixing plant to the site of the dam, and the cableway bucket discharges automatically into a hopper, suspended from the cableway and held stationary by snub lines while in use. At the bottom of the hopper is a chute 40 feet long, the free end of which may be swung in any desired direction. A gravel pit was established along the line of the Arrowrock Railroad and a steam-shovel outfit with screening and crushing plant was installed. This is about 14 miles from the dam and the sand and gravel are hauled to the mixing plant in standard-gage bottom-dump cars.

Tracks are extended over the tops of storage bins at the mixing plant and the cars dump the material directly into the bins. The sand-cement plant is across the river from the mixers, the transportation being through lines of 4-inch pipe by means of compressed air. The gates of the measuring boxes are also operated by compressed air. The average unit costs so far have been for excavating the foundation $1.07 per cubic yard, for spillway excavation, $0.65, and concrete in dam, $3.73 per cubic yard.—*Steam Shovel and Dredge.*



ON DECK OF WRECKING BARGE.

SALVAGE OPERATIONS ON THE EMPRESS IRELAND

BY FRANK RICHARDS.

It having been definitely settled that it is practically impossible to raise the great steamer Empress of Ireland so unfortunately sunk in the Lower St. Lawrence, the next thing is to save whatever is possible from the wreck, all the bodies of the drowned that can be reached, the mails and the bullion, of which there was a large amount. This work of salvage is being conducted by the well known firm of King & Wotherspoon, 24 State street, N. Y. City.

When working in the interior of a sunken vessel the divers very properly object to following intricate passages where air pipes may be fouled and life lines cannot have a direct pull, and especially where, as in this case, the working pressure approaches the limit of endurance. One diver, by the way, has already lost his life on this job. It was determined, therefore to cut a number of holes in the inclined side of the ship to give the men short and direct entrances to certain locations where they might expect to make the most important finds.

The general scheme was to cut a number of rectangular openings, say 4 feet or more in dimensions, right through the steel plates, giving the divers free passage through them, and four or more of these holes have been cut at the present writing. For each side of the rectangle a row of holes are drilled as close to each other as possible defining the opening all around and then the piece enclosed is torn out. This job is not as easy as the telling of it, the most difficult part of all, perhaps, being the drilling of the first one or two holes on account of the difficulty of applying the necessary pressure behind the drill to make it cut. After two corner holes have been drilled, hook bolts can be inserted and these are made to support a steel beam placed at such a distance from the sheet as to form a proper backer for the drill, and then the work is comparatively easy for all that row. The thin portions between the holes are not cut away by chisels or otherwise, but the sheet is torn away bodily by brute force. The surface being inclined at a considerable angle, hooks can be inserted in a number of holes at once along the bottom and then a powerful pull from a hoisting engine on the wreck will do the rest. In this it is not necessary to pull the sheet entirely off, but to swing it up and let it remain there like an open door.

The drill employed for this work is known as Little David No. 2, reversible. One of these drills is seen lying on the deck in the halftone with the wire wound air hose attached. At the depth where the drills were employed the water pressure was about 40 lbs., so that this had to be provided for by additional air pressure to correspond. The air is supplied by two Rand compressors, RC, of a type now somewhat obsolete, but which have done excellent service in other places. These are seen in the background and also a portion of the steam boiler temporarily installed to drive them. The air for the divers is supplied by the hand operated pumps, which the divers prefer. Six divers are employed with a large gang of men for the various service required. At this writing all the silver bullion and the mail sacks have been recovered by the divers and work has been discontinued for the season.—*From Engineering Record, with additions by the writer.*

DEPOSITION OF METALS BY SPRAYING*

BY R. K. MORCOM.

The spraying of metals from the molten state in order to produce a powder is an old idea, and the spraying of a liquid to produce a covering of paint, varnish, or enamel, is also well known. The subject of this paper is akin to them both, but has for its object the production of uniform metal deposits by means of a spraying process.

The earliest attempts in this line were carried out by melting the metal in a pot, forcing it through a fine nozzle under high pressure, and then with steam or a gas spraying it on to a surface. The spraying medium was kept hot by various devices, and an attempt was made to keep the metal molten right up to the moment of application. The fact, however, was observed that under conditions of temperature and expansion of the gases such that the metal could not have been molten throughout the process, adherent coatings were sometimes formed. These experiments, and careful observations of the spreading and adhesion of bullets fired at an iron plate, suggested the next stage of development. Metallic powders were driven at high velocity against the body to be coated by means of gaseous jets expanded from considerable pressure. The results achieved were a great improvement on the older method.

To produce the metallic powders the metal had, of course, to be subjected to one of the known pulverising processes, such as distillation, grinding, or spraying. The suggestion that the pulverisation and deposition could be combined in one apparatus was then made by the inventor, Schoop. The steady improvement of this apparatus in the laboratories of Schoop and his associates has resulted in the machine sketched in Fig. 1. The essential parts of the machine, or "pistol," as it is called, are a combined melting and spraying jet and a feed mechanism. The metal, in the form of rod or wire, is fed to the melting flame. The flame can be formed by coal gas, water gas, acetylene, hydrogen, etc., burning in air or oxygen according to the metal used. The gases are supplied at such pressures as to prevent blowing out and to ensure a highly deoxidising flame. The spraying jet can be of carbon dioxide, nitrogen, air, steam, etc.; it is fed at such a pressure as to produce a sufficiently high velocity for successful coating. The various pressures must be carefully kept constant by accurate gauges and reducing valves.

The feeding of the wire is accomplished by a small pneumatic motor, driven by the spraying medium, either in series or parallel with the main jet. The dimensions of the wire nozzle, and feed mechanism vary with the different metals, and the nozzles and feed mechanism are so designed as to be readily interchangeable.

For small work hand operation is sufficient; but, probably, when large work is undertaken, it will prove convenient to have mechanical traverse and control.

To obtain the best adhesion, the surface on to which the metal is sprayed must be thoroughly clean and of an open nature to give a key for the deposit. Sand-blasting with sharp

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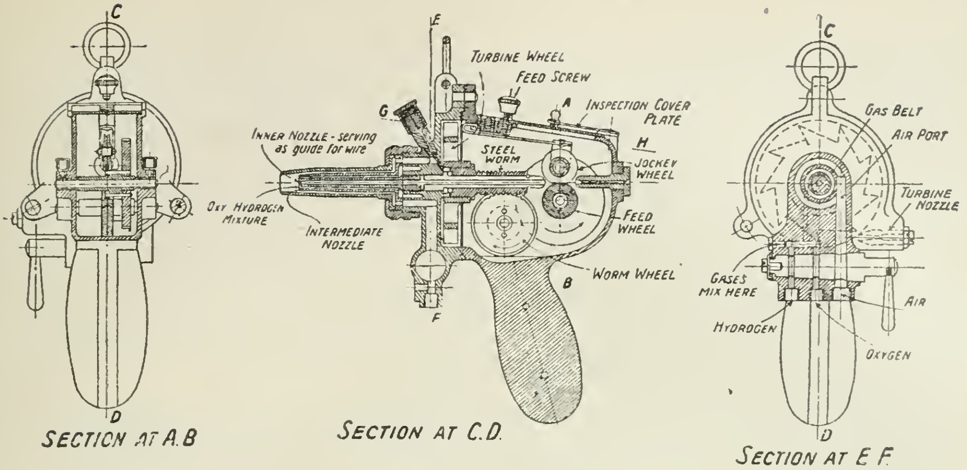
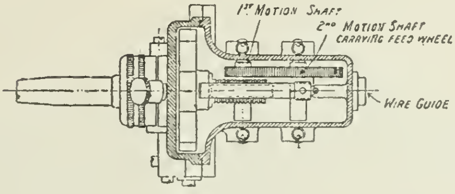
*Annual Meeting Institute of Metals.



Section at A.B

Section at C.D.

Section at E F.



Section at G H.

FIG. 1.

sand has been found best. Shot gives too polished a surface. Such surfaces as fabrics, wood, unglazed earthenware, and asbestos require only freedom from grease, as their surfaces give a natural key.

The mention of wood and fabrics as suitable substances to coat by means of an apparatus in which an intense flame is used may cause some surprise, which will be increased by the statement that celluloid, and even explosives, can be safely metal sprayed. To make this less remarkable it will be well to enter here upon a brief account of the theory so far developed to explain the operation, referring to Fig. 2 in the first instance.

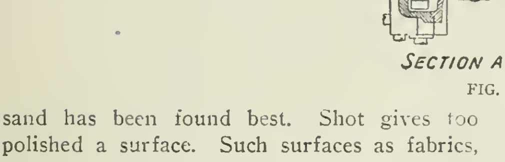


FIG. 2.

The melting jet is focused at A on the tip of the wire. The spraying jet, cold from expansion, strongly draws forward the products of combustion in the centre of its cone, and by its draft drags off minute particles of metal, either in the plastic or molten state. The central cone, therefore, consists of metal particles, some cooled to solidity, some molten, and some perhaps gaseous, surrounded by a protective reducing atmosphere. This cone is hurled forward with great velocity on to the object to be coated, BC, by the outer jet.

With a given design of jet there is only a certain volume left by the air-jet which can be filled with flame, and this flame has a limiting temperature which cannot be exceeded. The wire, passing through this cone of flame, receives heat partly by radiation, but chiefly by conduction, and becomes melted; but there is a definite limit to the amount of heat which can be picked up by the wire passing through the flame, and a definite limit to the rate at which it can be melted. This cannot be increased by forcing more gas into the flame, as the extra gas is merely blown away by the air-jet. It is possible to increase the rate of melting by shaping the nozzles so as to leave room for a larger cone of flame, and experiments are in progress on this point. There is, therefore, a definite and most economical quantity of gas which should be used in the pistol, this quantity being about 1.5 cu ft. of hydrogen per minute, and 0.5 cu. ft. of oxygen; or about 0.8 cu. ft. of coal gas to 0.65 cu. ft. of oxygen for the present standard designs.

In refractory metals these quantities may be increased slightly, as a slightly higher temperature can be obtained if the burning gases are under a pressure greater than atmospheric; and this occurs if the gas quantities are increased, the inner surface of the air-jet acting to some extent as an enclosing wall to the flame. On the other hand, for the more easily fusible and oxidisable metals, such as tin, lead and zinc, it is advisable to keep the gas quantities rather below the figure given, so as to avoid any possibility of overheating and burning any portion of the wire.

The outer jet performs a threefold function, it keeps the nozzles and wire cool, it cools the object, and it produces the requisite velocity. The velocity of the air leaving the jet will be independent of the volume discharged, and depends only upon the pressure at the jet, so long as there is no disturbance due to the entraining of air from the surrounding atmosphere. This, of course, will actually occur in practice, and the layer of air must have a certain thickness in order to prevent its being broken up, and having its velocity destroyed by mixing with the surrounding atmosphere.

In addition to this, the air-jet has to atomise the molten metal, and accelerate the particles up to its own velocity, so that to perform this a certain mass of air is required.

As at present constructed the standard pistol uses about 0.55 to 0.6 cu. ft. per minute for every 1 lb. per sq. in. air pressure, so that with an air supply at 80 lbs. per sq. in., which is a very suitable figure for ordinary spraying, the air consumption will be from 45 to 50 cu. ft. per minute. The mass of metal sprayed by this air will be from about 8 grammes (0.28 oz.) in the case of iron to about 200 grammes (7.05 oz.) in the case of lead.

The effectiveness of the cooling is readily shown by the fact that the hand can be held in the jet, so as to receive a coating of metal, without inconvenience.

The action of deposition is probably a complex one. The minute particles of solid metal are driven with such force against the object that in some cases they fuse, but, owing to their small relative size, are promptly chilled by the object to which they adhere. If any of the particles are molten or gaseous they will adhere. In addition, the suddenly chilled particles are possibly, or even probably, in the state of unstable equilibrium found in "Prince Rupert's Drops," and act like so many minute bombs, bursting on impact into almost molecular dimensions, and penetrating the smallest cracks and fissures of the object.

The process requires some care in manipulation as, by varying the conditions, it is possible to spray porous or non-porous coatings, and, with some metals, anything from a pure metal to a pure oxide. With care, however, non-porous, oxide-free, adherent coatings can be produced, of almost any metal on almost any solid.

In addition to metals, it is possible to spray fusible non-metals, or, by stranded wires, alloys of metals or mixture of metals with non-metals.

The process is so new that uses are still partly to be developed. But it is easy to see that it may have far-reaching value for protective coatings against weather or fire, for ornament, for electrical resistance and conductors, for the production of special alloys, for joint making, and for many other purposes.

Quite in a different category comes that of very fine casting. The surface of a pattern polished or slightly greasy, is most minutely copied, and it is possible to produce process blocks very rapidly. It may be useful to line moulds before pouring in a metal. The application of the process to the production of very fine or coarse metallic powders is being investigated.

The costs of the process are not prohibitive, and, even where higher than alternative processes, the great range and adaptability of this apparatus, and its independence of muffles, pots, etc., may make it preferable.

A table of gas-pressure and feed rates is appended to give some idea of costs. Experience and extended use on a commercial scale should soon reduce the cost of operation.

The bulk of the work has hitherto been

Metal.	Diam. of Wire used Milli-metres.	Rate of Feed, Grammes per Minute.	Gas used per Minute, Cubic Feet			
			Hydrogen.	Oxygen.	Coal Gas.	Oxygen.
Aluminium	1·0	9·5	1·5	0·5	0·7	0·6
Brass	0·8	17	1·5	0·5	0·8	0·65
Bronze	0·8	17	1·5	0·5	0·8	0·65
Copper	0·8	14	1·8	0·6	...	...
Cupro nickel	0·8	12	1·8	0·6	...	...
Gold	0·8	45	1·5	0·5	...	...
Iron	0·8	8	2·0	0·7	...	...
Lead	3·0	300	1·0	0·35	0·45	0·4
Nickel	0·8	9	2·0	0·7	...	...
Silver	0·8	18	1·5	0·5	...	...
Tin	2·0	200	0·8	0·3	0·35	0·30
Zinc	1·0	45	1·3	0·45	0·55	0·5

carried on in laboratories, but the apparatus is gradually becoming used in the more progressive factories, where extended facilities, and the knowledge of specialised requirements, will ensure a rapid improvement in technique and results.

The research on the lower melting-point metals has been greater than on the others, and undoubtedly the economy with them both can be greatly improved. Preheating of gases and air, supplementary flames acting in front of the main jet, and electrical methods of heating, are all still the subject of experiment.

AN AIR LIFT ENGINEERING FEAT

BY FRANK RICHARDS.

I trust that many readers will be interested, as I have been, in learning some particulars concerning a recently successfully completed plant which may be characterized as unique in more than one particular. The Morton Salt Company operates a permanent installation at Ludington, Mich., the original wells and the evaporating, packing and shipping establishment being on the shore of Lake Marquette, which here is about three quarters of a mile across and 35 feet deep. Some valuable wells which it was desired to bring into operation are situated on the other side of the lake, and it was desired to operate them without constant attendance or the expense of an isolated power plant.

Fig. 1, taken from the main plant, shows the site of the wells to be pumped, and Fig. 2 is a view of the main plant from well No. 1 in the previous view. The wells were to be pumped by the air lift, and the brine was to be conveyed from one side of the lake to the other, which compelled the laying of both a brine pipe and an air pipe to cross the lake, the former being 6 in. diameter and the latter 4 in.

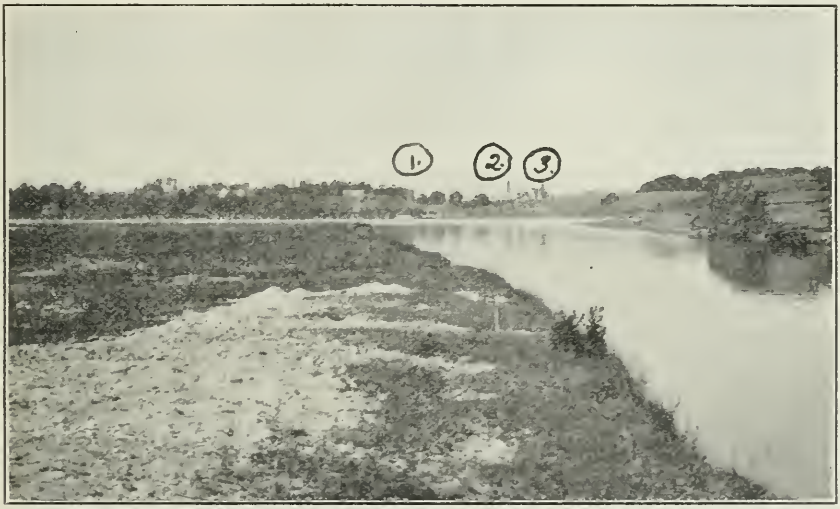


FIG. I.

LAYING THE PIPES.

These pipes were put in under the supervision of men furnished by the Union Tank Line Company, and the laying of them illustrates the reliable practice which unlimited experience has developed. It might be thoughtlessly called rough engineering, but complete success, quickly, surely, cheaply secured is never to be sneered at, especially by those who could not have done as well. The two complete lines were put down in less than 20 actual working hours. The line was first laid across the lake on the ice, and then, the ice being cut away, the pipes were lowered to the bottom. The joints of the pipes were the ordinary screw thread couplings, and, as there was no preparation of a bed for the pipes to lie in, they were left to accommodate themselves to their bearings as best they could.

Fig. 3 shows the pipes after they were laid just where they emerged from the lake toward the wells, No. 1 being the 6 in. brine pipe and No. 2 the 4 in. air pipe. Attention is es-

FIG. 2.

pecially called to the long, stiff clamp seen on the pipe in this view. This clamp covered the pipe and coupling and effectually protected the threads of the latter from the bending strains which occurred. Air was transmitted through the pipe at a pressure above 225 lb., and surely if this pipe could be made air-tight—as it was—there should be no excuse for air leaks anywhere.

THE COMPRESSOR.

The compressor installed at the power house for serving these wells is shown in Fig 4. This is an excellent photo of a machine as taken when running at full speed. The arms

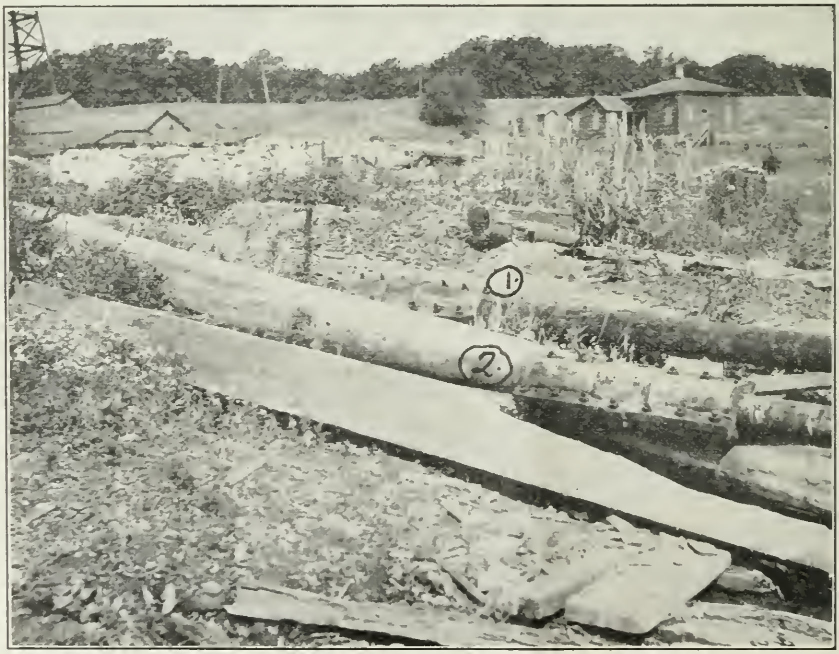


FIG. 3.

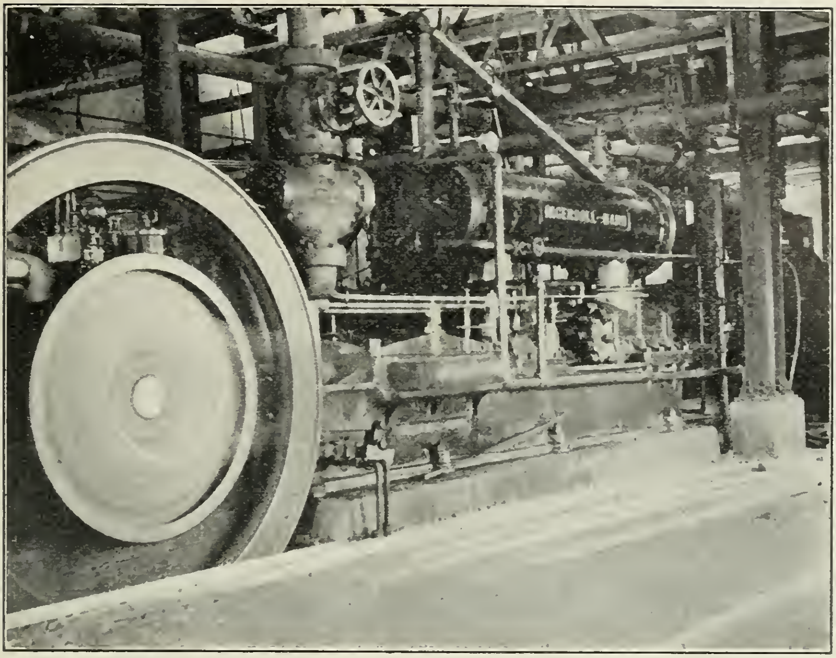


FIG. 4.

of the flywheel have entirely disappeared, as has also the crank pin, and only a slight blur outlines the area traversed by the connecting rod. The crank disk shows an overhanging lip which is valuable for catching oil that otherwise would be thrown off by the centrifugal action. The gutter around the disk can of course be wiped out whenever the compressor is stopped. There are no immediately novel features about the compressor; it is of the straight line type technically designated as Ingersoll-Rand, AA2. The steam cylinder

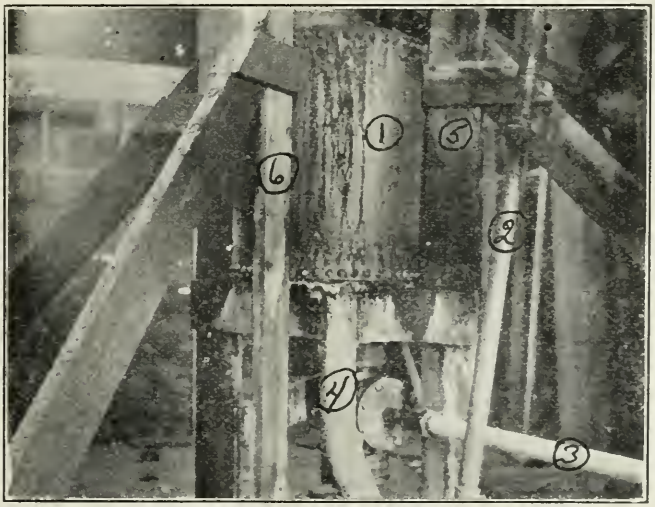


FIG. 5.

is between the flywheels and the piston inlet, low pressure air cylinder is at the further end, with the high pressure air cylinder inside and connected by a large overhead intercooler. The steam cylinder is 24 in. diameter, and the air cylinders are 19½ in. and 9¼ in., respectively, with a common stroke of 24 in., and a capacity, at 140 R. P. M., of 1100 cu ft. of free air per min. delivered at a pressure as high as 300 lb., which, by the way, is higher than the normal working pressure for a machine of this type.

THE AIR LIFT.

The air lift operation in this case is somewhat complicated. The air is delivered to the wells at a pressure of 225 lbs. The pipes are carried down to a depth of 700 ft. while the lift is 335 ft. to the booster, which gives a submergence of about 53 per cent., and a surplus of pressure in the booster after the delivery of the brine. This surplus pressure, about 22 lb., is employed to drive the brine through the 6 in. pipe under the lake 4400 ft. and elevate it 48 ft. to the settling basin, from which it is distributed to the evaporators and grainers. Besides doing this work there is a considerable volume of air remaining at the booster which is carried down to the lake where it serves as an air lift to elevate fresh water high enough to flow back to well No. 2. It flows down this well by gravity into a common cavity where it dissolves the salt, forming the brine which is pumped through wells 1 and 3 to the surface.

Referring to Fig. 5, 1 is the booster itself, 2 is the surplus-air pipe for the fresh water service, 3 is the air-and-water delivery pipe from the wells, 4 is the 6 in. pipe for the long run of the brine to the other side of the lake, while 5 and 6 call attention to the mode of supporting the booster to make all the pipes accessible.

Economy of operation was considered in this installation, but the main point was reliability. The air lift in detail is not as simple as above outlined. Harris pumps of special design being employed. The air actually passes down the wells outside of and around the brine line, or, in other words, the discharge pipe is inside the air pipe.

There would have been no economy in using a condenser for the steam in this case, as all the exhaust is used under the evaporating pans.

For the photos and for the information here presented I am indebted to Mr. James C. Gillies of the Chicago office of the Ingersoll-Rand Company of Illinois.—*Practical Engineer.*

THE FLY AND THE BOTTLE

BY A. L. HODGES.

The old story about the fish being put into a tub of water and not making it weigh any more has of course long been disproved; but a new proposition in the form of a fly and a tube has arisen to worry those so minded. Suppose you have a tube that weighs so much, and then place a fly into the tube and close it so that it is air tight. Now of course, if the fly alights on the side of the tube, his weight is added to that of the tube; but suppose that he is just flying around in the tube without touching the sides? It is inevitable that his weight must come just as it does when he is on the side; for we are weighing an air-tight tube and its contents, and it is immaterial about the condition or position of those contents, provided the tube is full of something. The fly, to sustain himself, has to beat downward with his wings, and thus exert pressure on the inclosed air equal to his weight. In case there was a vacuum in the tube and the fly was momentarily dropping inside without touching the sides, he would of course weigh nothing on the scales in this position.

But the hardest question is yet to come. Suppose that the tube is open to the air and that the fly is flying around inside without touching the sides, then will his weight be added or not? The answer to this is the same as when the tube is closed, but will have to be extended somewhat. Whether the extension will apply to the closed tube, however, is a question, and depends on whether we may consider it a system of isolated forces. When the fly is not moving up or down he is exerting exactly his own weight downward, whether the tube be opened or closed; therefore his weight would have to be added if he was not touching the tube but was simply keeping at one spot in the air in the tube. If he flies upward, however, he is exerting more than his weight downward, and will add more than his own weight. If he flies or falls downward, he does not add quite his weight to the tube's. If he flies downward faster than sixteen feet the first second, he will actually make the tube lighter on the scales than it is without the fly.

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CHEAPER WORKING AND MORE WORK

Whatever we do if we are interested in our work; if we aim to accomplish the most and to produce the best, with economical use of means and methods, which is the universal attitude of modern industry, it invariably results that what we find to do is constantly done quicker, cheaper and better. One rarely can tell from the rate and cost of our working to-day what these conditions may be far in the future, but improvement and increasing facility we may be sure of.

The tools and apparatus employed in our work are constantly being superseded by better, even before they can be worn out, and this is nowhere more true than in the lines of industry which specially interest our readers. Few who are not in close touch with the actual thing can realize what improvements have developed within a decade in air compressors and rock drills and in the way they are used. Compressed air has not changed its characteristics, and it still is the great reliance where rock excavation is to be rushed, but there is less noise and display.

Only a little while ago right in the heart of New York City the Pennsylvania and the New York Central railroads were building their great stations, cutting deep and wide into the solid rock for yard room as well as for the buildings. There were great power houses for the compressors, and over the rocks were distributed the heavy tripod drills, laboriously shifted from hole to hole. At the present moment, and only a hundred yards from where we write, there is another great and deep hole being cut in the rock as required for the new subway construction. Of course compressed air had to be employed for the work, and there is a compressor somewhere, but it is not easily found, and in place of the heavy drill and tripod there is a Jackhamer, a one-man drill which the man can carry under his arm or on his shoulder, and with which as soon as he has finished one hole he is immediately ready to begin another.

Just a look and the striking change is impressed upon us, and we have no wish to "improve the occasion" by any funeral sermon. Rock drilling or rock excavation is vastly cheaper than it was. The cost of mechanical equipment is cut in half and the cost of operating is proportionately reduced, so far as the drilling is concerned, which means, for the first part of it, that those who build machinery of this class have perhaps not more than one-half the amount of work to supply the normal demand.

This, however, is not the whole of it. The cheapening and the quickening of our facilities for doing work lead invariably to the planning and to the doing of more work. Many schemes which would have been too costly by the old way come to be possible and are set going. New undertakings are planned ahead and each thing completed leads to several new things to be done. The way to get work is to work cheaply and efficiently.

This is perhaps nowhere more true than as regards the local work of building and extending the Metropolis, in which compressed air and the rock drill are such constant and appreciated workers. There is now within its limits one of the world's great engineering works approaching completion and others are just beginning, neither of which would it have been possible to think of but for pneumatic aid. These latter subways and tunnels under way are not the end of anything, but soon will be intermediate in a series which is not to stop. Not only must there be more and more subways for passenger traffic, but is it not time also to be providing for the conveyance of merchandise and freight?

And so the work will be coming along, for the whole nation and for all the world.

PREHISTORIC MINERS

BY GARRET P. SERVISS.

Prehistoric man is continually becoming plainer to our eyes as science clears away the mists of early time, and the more we see of him the more we find to admire in his achievements. Recently extensive explorations have been undertaken of the mines that were dug by men of the Neolithic age at Spiennes, not far from the present city of Mons, in Belgium.

Mines! What had prehistoric man to do with mining? What was he digging for? Digging for that which for him was as valuable and as indispensable as iron is for us—flint. He knew nothing of metals, but he had to have spear and arrow heads for himself, kitchen knives for his wife, and a variety of working tools to keep the whole family from mischief, and he made these things out of flint.

The first makers of flint tools and weapons were very rude craftsmen, and they took their raw material wherever they could find it—a chunk of flint picked up here or there served their purpose. But early man was not long in demonstrating that he was no slave of mere instinct, like bees and ants and other animals which know no progress, and do the same things in the same way for a million years. His intelligence showed him that he could improve upon himself and upon nature by setting his mind, his invention at work.

As his tools became finer in quality and finish he needed better materials to work with, and he set out to find them. Some great flood, perhaps, cutting deep into the chalky soil, showed him that far beneath the surface there were layers of flint nodules much superior in quality to those that he had hitherto used. He felt that he must have that better kind of flint, cost what it would, and so he became a miner.

The explorations to which I have referred show that certainly hundreds, and probably thousands, of deep mine-wells were dug by Neolithic men in the chalky plateau at Spiennes in order to reach deposits of specially fine flint existing at a depth of fifty feet beneath the surface of the ground. There was plenty of fairly good flint above, but these workmen were becoming very particular in their judgment of the material that they used. They wanted tools and weapons that would take and keep an edge and that would not crumble in an emergency. In those days, just as truly as to-day, the best weapon won the battle, the best knife struck deepest.

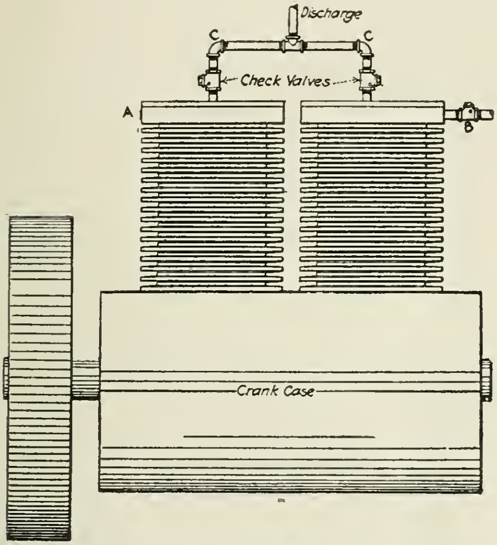
Photographs from the excavations show how ingeniously the men of that time dug their mines. They knew as well as the coal miners of Pennsylvania how to support the roofs of their galleries.

Around the openings of the mines, at the surface, indications are found of the existence of the workshops of the artificers in flint. There, too, as well as in the abandoned mines, are found many flint picks, whose wooden handles decayed and turned to impalpable dust many centuries before Rome was founded. It was with such implements that this vast system of mines and galleries was excavated by those early, simple men, whom we are accustomed to regard as far below even the savages of to-day.

But they possessed the virtue of perseverance. They knew what hard unceasing work meant. Measured by the effort required to get it, their flint was as precious as our gold.

"If you would appreciate the industry of these Neolithic men," says one of the investigators of their work, "take one of those flint picks, just as it dropped from their hands, fasten a handle to it, and then go to work and dig a well fifty feet deep, and galleries hundreds of feet long, and see how long it will take you."

Those were, indeed, the days of hard work; the days when man was finding his true worth, and when the value of labor was measured not by hours but by results.—*The Sun.*



A GAS ENGINE TRANSFORMED INTO AN AIR COMPRESSOR

The sketch here reproduced from Power shows how a correspondent rigged up an old gas engine to serve as an air compressor. A perhaps sufficient excuse or explanation was that the air requirement was something of an experiment and that only about 40 lb. pressure was wanted.

The engine had a closed crank case and a belt wheel on one end of the shaft. The spark plugs being set in as at A, it was only necessary to ream out and tap these nobs to ¾ in. and screw into each a close nipple and a common check vavle as at B for the intake. The head plates were drilled and tapped for ½ in. nipples with check valves for the discharges. The two checks were then piped together—using a union forgotten in making the sketch—and the compressor was ready to run. The cost of the change was about $6.00.

Of course it worked, but the valves were not suitable for the purpose and the clearances must have been so large that volumetric efficiency was out of sight.

LAYING A 12-INCH PIPE LINE 120 MILES LONG

Readers of Compressed Air Magazine are naturally interested in the laying of pipe lines, although the length of the line here spoken of is greater than compressed air practice usually calls for. It, however, is connected with compressor service and carries high pressures, both particulars combining to make legitimate reading for us.

The 12-in. line here spoken of is for the conveying of natural gas at high pressure from Inez, Kentucky, to Louisville. The work of laying the pipe was described in an interesting paper by Lewis S. Streng before the Engineers' and Architects' Club.

The work was begun on Aug. 8, 1913, and completed and tested on March 12, 1914. The unusual difficulties of the undertaking were due largely to the character of the country.

The work on the Louisville end was simple compared to that in the mountains. Delivery of material was a problem. In some places, the nearest railway was 40 miles distant, and the wagon roads hardly deserved the name. A team would start from Paintsville with two lengths of pipe, the load amounting to less than a ton, and return light, taking three days for the round trip. About 150 teams had made several trips, the roads were in miserable condition, requiring a repair gang to keep them passable. On the Louisville section, much foreign labor was employed, but not back in the hills. The mountaineers drove the foreigners out of the country. The mountaineers were splendid workmen. They would walk four or five miles before daybreak, do a day's work and go back home with a lantern.

DETAILS OF PIPING.

The steel pipe used was 12-in. inside diameter, ⅜-in. thick, weighed 45 lb. per ft., and averaged 20 ft. to the length or "joint" as it is called. Each joint was tested at the mill at 1,000 lb. per sq. in. pressure and carefully inspected for defects. The couplings used were steel forgings of the familiar Dresser type, consisting of a central ring, two rubber-compound gaskets and two followers drawn up by steel bolts. Screw pipes were used in all river and creek crossings, with leak collars with rubber gaskets placed over each of the screw couplings, and over all this was bolted a heavy split-iron casting, or river clamp. Under all rivers, two lines were laid with valves and Y's at either end. At railroad crossings, the pipe was placed in a 20-in. cast-iron casing, fitted with valves, on either side of the right-of-way. Eventually, a second line will be laid, with provisions for cutting out any section desired. In case of trouble, the check valve will prevent the escape of gas from the Louisville end.

TESTING.

The line was tested as laid before any of the couplings were backfilled. For testing purposes, two temporary compressor stations were erected, one on the Kentucky river, about 7 miles above Frankfort, and the other on Mud Lick in Johnson county. The line was pumped up to 350 lbs. per sq. in. pressure, and then carefully inspected for leaks. The excellent results obtained by this method were shown by a 48-hour acceptance test of the whole line last February. At 350 lbs. per sq. in. pressure, the leakage in 24 hours was less than ¼ per cent.

CONSTRUCTION PROCEDURE.

The construction force was organized in two divisions, one for the mountains and one for the Blue Grass, each in charge of a general superintendent. The headquarters of the mountain division was at Paintsville, with a territory to be covered of about 65 miles. The other division was about 115 miles long, with headquarters at Lexington. Each division had two large gangs, with full camp equipment. These gangs started at the compressor stations and worked toward the ends of the divisions. In addition, each division had a special gang which installed the river, creek and railroad crossings. After more than half the work was finished, another gang was organized to hasten the completion of the work. The number of men in each gang varied from 200 to 500. During the preceding summer, a survey had been made, and most of the right-of-way obtained. Stakes were set every 200 ft. and the first job of the construction gangs was to clear the right-of-way from 16 to 20 ft. wide. The digging crew then roughed out the trench throwing the earth to one side, the other side being left clear for pipes. Where rock was encountered, a drill gang came next and the way blasted. After them came the graders, who trimmed the trench to proper dimensions, normally 18-in. wide by 36-in. deep. Changes of grade up to perhaps 5 deg. could be made in the couplings; but in general the straight pipe was laid at an even grade, and fire bends made where necessary. A small gang went ahead inspecting the pipes, dressing off any roughness at the ends, and making the necessary bends. The pipe was then laid on skids over the trench and the couplings fitted. After a section had been finished, the lengths varying from 100 ft. to ½ mile, according to topography, the gang came back and lowered the pipe into the ditch. Lastly, followed the backfilling gang. On level stretches, teams with drag-scrapers were used. On the slopes, breakers were built to hold the fill and leave the couplings exposed. Following the laying of the sections in the trench and their testing out, a small gang covered the couplings and trimmed up the fill. The task of hauling material was a serious problem, as has been described, but that of stringing the pipes along the right-of-way was even more difficult. At convenient locations, the pipe could be unloaded where desired, snatch teams being added as required. Frequently, however, block and tackle were required. Five or six teams were sometimes needed to move a single joint. On some of the trenching, gasoline-driven drag-line ditching machines were used. In good going, they could dig 2,000 ft. of 18x35-in. trench in a day; but they were useless on grades, or where rock was encountered. They traveled very slowly and lost much time by necessary detours. The best day's work reported by any of the gangs was about 1 mile of ditch. Occasionally, pipe gang would report as high as 6,000 ft. of pipe laid in a single day; in the rough country, 750 ft. was an average day's work. At times, when practically the whole trench was through rock, a gang of 200 men could not make more than 200 ft. per day.

One horsepower-hour is equivalent to 2545 B.t.u. In a pound of Pocahontas or other coal containing 15,000 B.t.u., there is enough energy, could it all be utilized, to supply almost 5.9 hp.-hr., or to raise a weight of one pound 2210 miles against the force of gravity. This energy would lift a 100-ton locomotive 58 ft.

COST OF DRIVING THE JUALIN TUNNEL FOR JUNE, 1914

Distance driven	539 ft.
Average per shift	17.96 ft.
Average round	4 ft. 8 in.

Total Wages

Labor	Number per Shift	Number of Shifts	Rate per Shift	Total Cost
Machinemen	2	199	$3.50	$696.50
Machine helpers	2	180¼	3.25	585.80
Muckers	4	376¼	3.00	1128.25
Carmen	2	27½	3.00	82.50
Blacksmith	1	31	4.05	125.25
Blacksmith helper	1	23	3.50	80.50
Powderman	1	30	3.50	105.00
Compressor man	1	30	4.80	144.00
Teamster	1	34	4.00	136.00
Dumpman	1	22	3.50	77.00
Total				$3160.80
Foreman	1	30	$6.00	$180.00
Shift bosses	2	60	5.00	300.00
Total				$480.00

Supplies and Labor per Foot

	Cost per Ft.
15-in. No. 18 gage fan pipe	$0.70
3-in. iron pipe	0.20
1-in. water pipe	0.045
30-lb. rail	0.40
No. 4 copper wire	0.21
Oil	0.03
Candles	0.07
Powder, 200 boxes, $7 per box	2.59
Fuse, 22,000 ft., $4.75 per 1000 ft	0.18
Caps, 33 boxes, $1.25 per box	0.075
Labor	5.86
Bosses	0.89
Bonus	3.04
Waterproof goods allowance[1]	0.86
Total cost per ft	$15.15

[1] Boots, slickers, hats for 34 men at $15 for each.

FAST TUNNELING IN ALASKA

The accompanying figures cover the work done in driving the Julian tunnel in June, 1914. The work is being done by the Algunican Development Co., L. K. Kennedy, manager in charge, at Jualin, a few miles north of Juneau on the Alaskan coast. The tunnel will serve for prospecting and drainage and is to be 7000 ft. long. It is being driven in what is known as Jualin diorite. The drilling is done with two No. 18 Leyner machines. During June tramming was conducted by hand. During the month the entire 1100 ft. of track then laid was torn up and relaid with heavier rails. This work resulted in the loss of 4 rounds. At present mules are used for tramming and better footage is being made.

It will be noticed that the drills are Leyners as against the big pistons used on the Sheep Creek tunnel recently completed by the Alaska Gastineau not many miles away. The footage for June is an excellent showing. The two tunnels should afford an unusual chance for comparison between the two types of machine. The crew consists of tried tunnel men; it was organized late in May and is in charge of A. Rieandeau who has all the work systematized to the last degree.—*Eng. and Min. Journal.*

NOTES

We are glad to welcome again the Mexican Mining Journal. It remarks that " it is good to get mail every day instead of once in God-knows-when, as it was in the recent past." We learn from it that the first through train in two years from El Paso to Mexico City arrived in August, and that now mail, freight and passenger service have been resumed and are maintained on all railroad lines throughout Mexico.

According to an estimate by Sir John Murray, the total annual rainfall upon all the land of the globe amounts to 29,347.4 cubic miles, and of this quantity 6,524 cubic miles drain off through rivers to the sea. A cubic mile of river water weighs, approximately, 4,205,650,000 tons, and carries in solution, on the average, about 420,000 tons of foreign matter. In all, about 2,735,000,000 tons of solid substances are thus carried annually to the ocean.

A heavy rainfall occurred in the Canal Zone near Gatun on August 12. The maximum fall for 1 hr., 3.45 p. m. to 4.45 p. m., at Gatun, amounted to 4.72 in. This hourly record has been exceeded but twice on the Isthmus since automatic records have been kept, namely, 5.86 in. in I hr, at Balboa on June 2, 1906, and 4.90 in. at Colon on Oct. 8, 1908. The heaviest fall on Aug. 12 occurred at Agua Clara reservoir, amounting to 7 in. in a little less than two hours.

A famous English firm that manufactures a large luxurious car, a well-known American firm manufacturing a cheap car, and a firm equally high in the light car world all employed the same ore for their cylinder castings. Questioned on the subject, the large car firm uses it "because it is the best," the American firm "because it is the cheapest," and the light car firm "because it is best and cheapest." The answer of the American firm is explained by the fact that with the best ore there is a smaller percentage of faulty castings which have to be scrapped.

A test is now being made of lighting the port of Montevideo with high-pressure incandescent gas lamps. A trial installation of four Keith lamps, each of 3,000 candlepower, has been put up by the Montivideo Gas Co. These lamps which are hung on iron columns some 20 feet high and placed along the asphalt way leading to Mole A, have two mantles each and are lighted by gas at a pressure of 2,030 to 2,540 millimeters (80 to 100 in.) of water (2.9 to 3.6 lb.). The mantles are inclosed in separate coverings of silica, which, besides having the advantage of being small, are not subject to damage or breakage, even if they become wet.

Power is now carried over the new line of th Nevada-California Power Co. from the generating plant in the Sierra Nevada mountains near Bishop to El Centro in the Imperial Valley, a distance of more than 400 miles. This is the longest power line in the world, being almost twice as long as the transmission line of the Pacific Light & Power Co., to Los Angeles. At the opening the new line carried 2000 hp. of electric energy. It has a capacity of 10,000 hp. The greater part of the power will be used for irrigation pumping. Underneath the Imperial Valley lie inexhaustible supplies of water, which must be pumped to the top of the ground to be available.

The firm of Dunford & Elliot, Sheffield, England, has recently introduced a patented process for manufacturing hollow metal rods. By this process hollow steel bars from ¾ in. to 3 ins. in diameter and 20 ft. long are produced by rolling from a drilled ingot. After the piece has been pierced it is packed with a kind of sand which is capable of resisting high temperatures. The hole is plugged at each end with metal plugs and the billet is then heated and submitted to repeated rollings until a bar of the required dimensions is produced. It appears that the packing material acts as a fluid or as an elastic mandrel, thus maintaining a hole through the bar. After elongation the core is removed by a special process.

A medal to be known as the Franklin Medal, and to be awarded from time to time in recognition of the *total* contributions of individuals to science or to the application of physical science to industry, rather than in recognition of any single invention or discovery, however important, has been founded by Samuel Insull, Chicago, Ill., under the auspices and custody of the Franklin Institute. In founding this medal Mr. Insull has provided $6000, of which $1000 is to be used in securing appropriate designs and dies for the medal and diploma. The remaining $5000 is to be held in trust in perpetuity, and the interest is to be used from time to time in awarding the medal. The intrinsic value of this is not to exceed $75.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

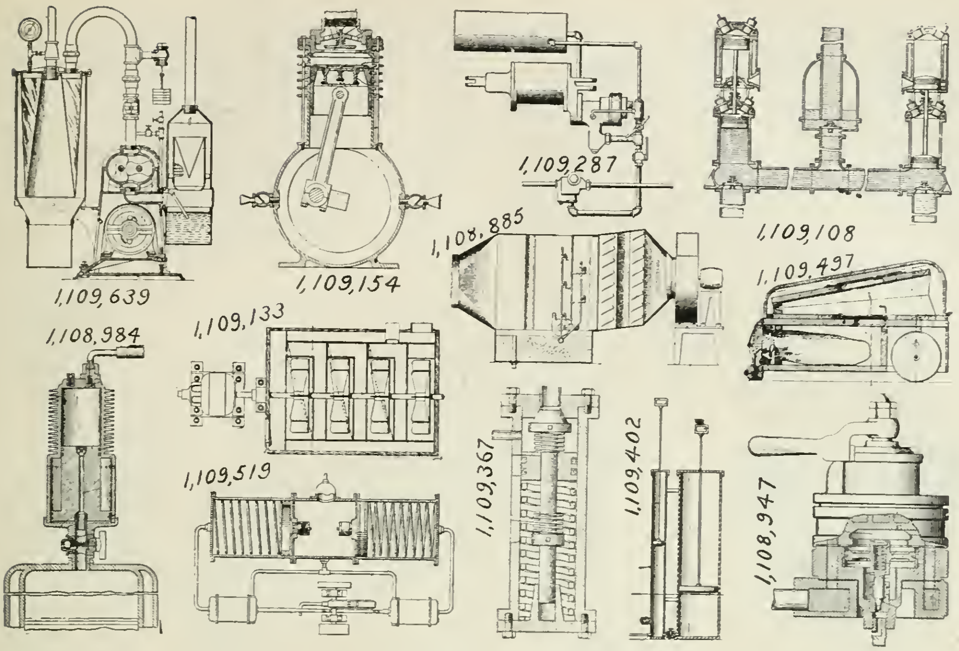
SEPTEMBER 1.

1,108,885. SPRAYING MECHANISM. Allen A. Blomfeldt, Chicago, Ill.

1,108,930. AIR-SPRING. Wilhelm L. Ostendorf, Wilkins township, Allegheny county, Pa.

1,108,947. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,108,952. PNEUMATIC JACK. Nathaniel B. Wales, Saginaw, Mich.



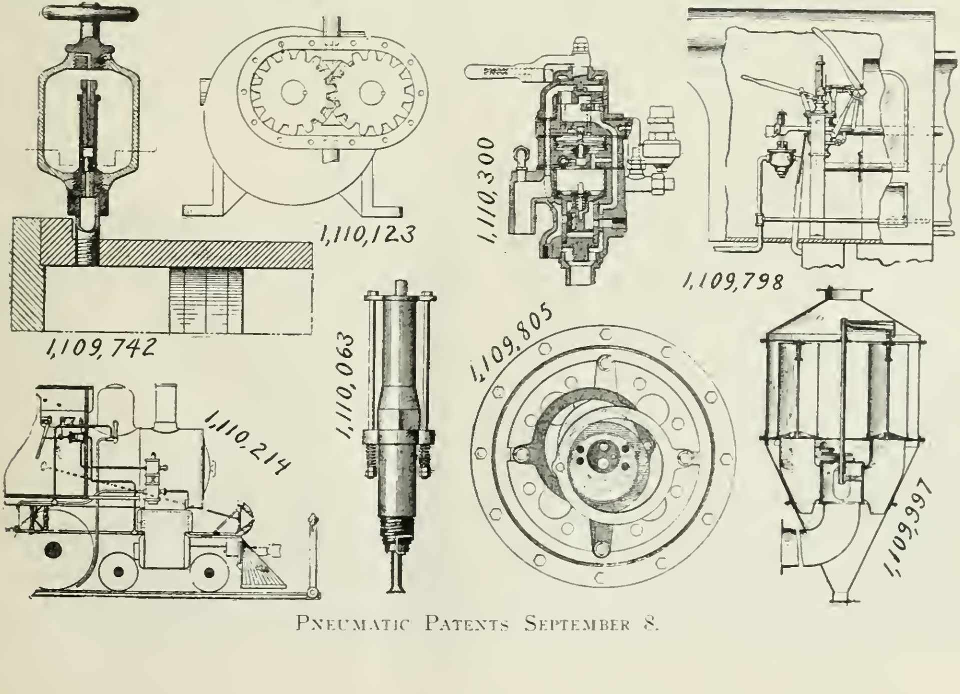
Pneumatic Patents September 1.

1,108,984. APPARATUS FOR COMPRESSING AIR. Herbert H. Frey, Chicago, Ill.

1,109,092. TRACK-SANDING APPARATUS. Harry Vissering, Chicago, Ill.

1,109,108. METHOD AND APPARATUS FOR PUMPING LIQUIDS. Henry M. Chance and Thomas M. Chance, Philadelphia, Pa.

1. A method of pumping liquid which consists in applying pressure, generated by the power impulse of a prime mover actuated by an elastic medium, to a confined body of liquid, a portion of which is interposed between an inlet for liquid and a region of discharge and a portion of which is interposed between said prime mover and a

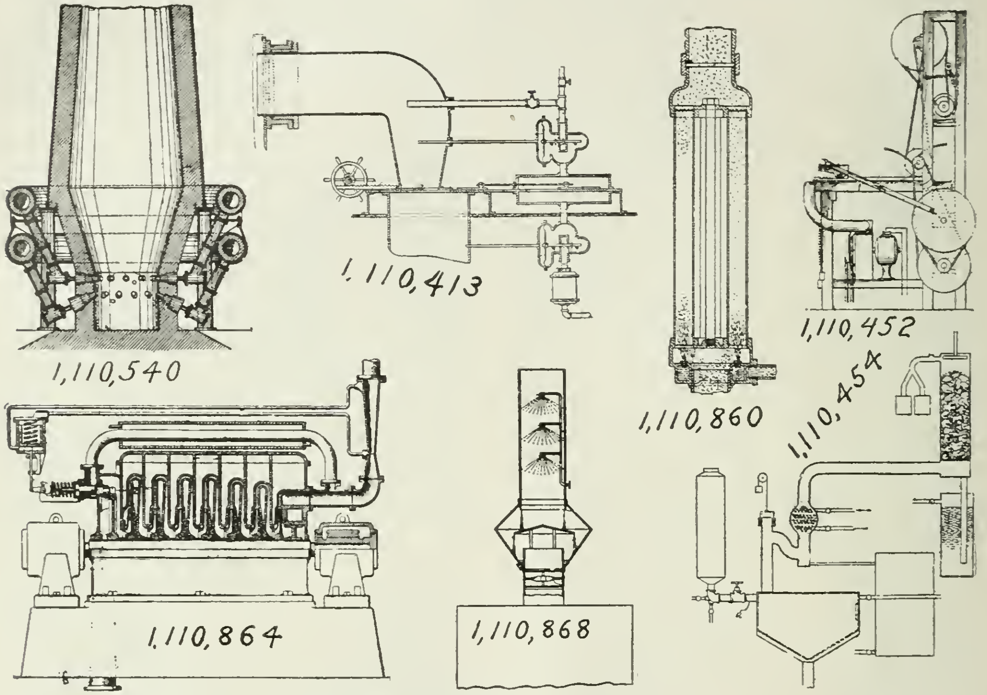


Pneumatic Patents September 8.

second similar prime mover, in causing said pressure to commence the discharge of liquid at said region of discharge and simultaneously to cause said second prime mover to commence a return stroke thereof, in causing the movement of said second named portion of liquid after the completion of the power stroke of the first named prime mover to effect the completion of the return stroke of the second prime mover and simultaneously therewith to draw in a new increment of liquid.

1,109,130. PNEUMATIC SOLE FOR SHOES. Edgar C. Kaye, Chicago, Ill.

1,109,133. CENTRIFUGAL BLOWER. John S. Melchers, New York, N. Y.



Pneumatic Patents September 15.

1,109,146. PNEUMATIC VEHICLE-SPRING. Ross M. G. Phillips, Harrison, N. J.

1,109,154. AIR-COMPRESSOR. John H. Thomas, Bloomfield, N. J.

1,109,171. AIR PURIFYING AND COOLING DEVICE. Carl F. Lundeberg, Hartford, Conn.

1,109,174. AIR-VALVE. Carl H. Peterson, Hartford, Conn.

1,109,180. PNEUMATIC PLUG FOR HEELS. Benjamin Rosenberg, New York, N. Y.

1,109,193. AERATING APPARATUS. Oscar Zistel, Sandusky, Ohio.

1. Apparatus for transporting fish comprising in combination, a car and a water tank carried thereby, an air pump, connections for conducting air from the pump to the water within the tank, an electric motor for driving said pump, a storage battery, and means operated by the prime mover of the car for charging said battery.

1,109,287. AUTOMATIC RETAINER FOR AIR-BRAKES. John O. Harrison, Boone, Iowa.

1,109,367. FLUID-BLAST STOKER. Joseph M. Shults and Frederick W. Shults, Baltimore, Md.

2. A stoker for feeding fuel to furnaces by blasts of fluid under pressure, comprising the combination of a fuel chute in which the charge of fuel is to be seated; a fluid-pressure cylinder having an outlet port; a valve controlling said outlet port and having a stem provided with a collar that is adjustable longitudinally along said stem; a piston movable in the cylinder and having a central hole through which loosely passes that part of said valve-stem that is between the valve and the said collar; means to supply fluid-pressure to the cylinder to operate the piston, and a blast-pipe communicating from the said outlet port to the fuel chute.

1,109,402. LUBRICATING DEVICE. Ernest Odes Cox, Wetumka, Okla.

1,109,419. PNEUMATIC PUMP. Andrew J. Hubbard and Carl A. Swanson, Jacksonville, Ill.

1,109,492. COMBINED VACUUM-CLEANER AND CARPET-SWEEPER. Morris S. Wright, Worcester, Mass.

1,109,497. APPARATUS FOR CLEANING CARPETS AND THE LIKE. Morris S. Wright, Worcester, Mass.

1,109,519. AIR - COMPRESSING MACHINE. Altomon L. Ellis, Eden, Miss.

1,109,639. VACUUM-CLEANER. William S. Sutton, Rockford, Ill.

SEPTEMBER 8.

1,109,714-5. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.

1,109,742. LUBRICATING DEVICE. Walter S. Earley and Robert W. Kilpatrick, Philadelphia, Pa.

1,109,798. AUTOMATIC SAFETY DEVICE FOR LOCOMOTIVES. James H. Smith, Port Murry, N. J.

1,109,805. AIR COMPRESSOR OR MOTOR. William A. Warman, New York, N. Y.

1,109,827. PNEUMATIC - DESPATCH - TUBE APPARATUS. Merton L. Emerson, Braintree, Mass.

1,109,997. AIR - PURIFYING APPARATUS. Guido E. Lob, Chicago, Ill.

1,110,063. PNEUMATIC TOOL. Paul Koroknay, Lyndora, Pa.

1,110,067. PNEUMATIC ENGINE OR TOOL. Joseph D. MacDonald, Butte, Mont.

1,110,123. AIR-COMPRESSOR. Adolph F. Feller, Berkeley, Cal.

1,110,155. PNEUMATICALLY - OPERATED PERCUSSIVE HAND-TOOL. Clement Henry Stevens, Las Palmas, Grand Canary, Canary Islands.

1,110,214. AUTOMATIC TRAIN-STOP. William E. Lawn, Rochester, N. Y.

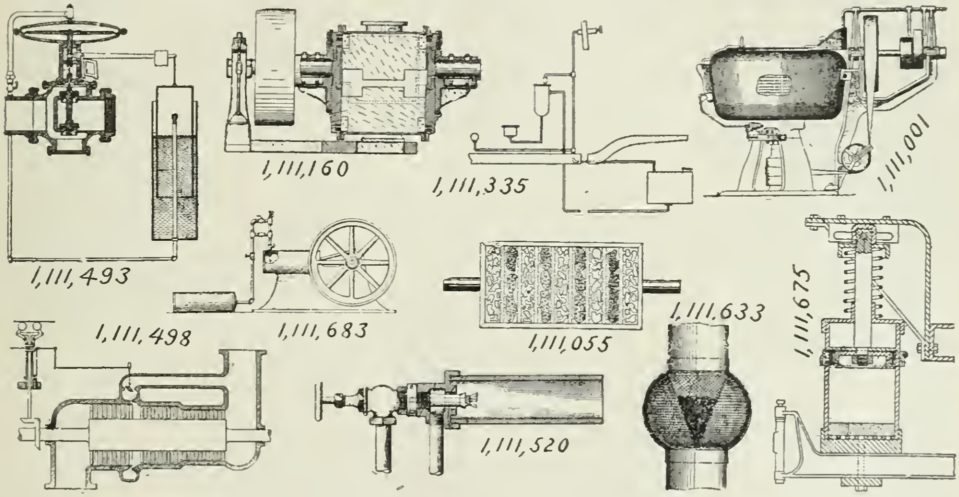
1,110,300-01. FLUID-PRESSURE BRAKE APPARATUS. Murray Corrington, New York, N. Y.

SEPTEMBER 15.

1,110,364. PNEUMATICALLY - ACTUATED MUSICAL INSTRUMENT. Peter Wiggen, Chicago, Ill.

1,110,413. APPARATUS FOR MEASURING THE FLOW OF FLUIDS. Thomas B. Wylie, Pittsburgh, Pa.

1. The method of measuring the volume of flow of a fluid, which consists in causing it to flow through a controllable opening, causing another fluid to flow through another controllable opening having its area definitely proportioned to the area of the first named opening, maintaining a difference in the pressures at opposite sides of the last named opening which is proportional to the difference is pressures at the opposite sides of the first named opening, and measuring the fluid which flows through the second opening; substantially as described.



Pneumatic Patents September 22.

1,110,450. DUMPING - WAGON. Charles Matthews Manly, Freeport, N. Y.

1,110,452. PLUME - DRYING APPARATUS. Homer Methot, Red Bank, N. J.

1,110,454. RECLAIMING WASTE PRODUCTS IN THE MANUFACTURE OF SULFITE FIBER. Hugh K. Moore and Robert B. Wolf, Berlin, N. H.

3. The herein described process of recovering sulfur dioxid, which consists in first filling an open blow pit with steam to remove the air therefrom, then closing the pit and connecting the same with an air pump, then discharging the contents of a pulp digester into said pit, and condensing the vapors rising from the blow pit, and recovering the uncondensed sulfur dioxid.

1,110,540. PROCESS OF SMELTING AND PURIFYING IRON. Gustave R. Gehrandt, Chicago, Ill.

1. The herein described process of producing a purified iron which consists in smelting the ore, collecting the smelted ore in the hearth of the smelting furnace and in causing an air-blast to enter the smelted iron and to enter and pierce the same at an angle oblique to the level of the smelted iron, said air-blast being passed through the iron simultaneously as the supply of iron in the hearth is replenished by freshly smelted iron from above.

1,110,860. VACUUM - PRODUCER. Charles Henry Atkins, Springfield, Mass.

1,110,864. CENTRIFUGAL COMPRESSOR. Otto Banner, Easton, Pa.

1,110,868. ARRANGEMENT FOR PRECIPITATING DUST BY MEANS OF WATER. Georg J. Bauer, Frankfort-on-the-Main, Germany.

SEPTEMBER 22.

1,111,001. PNEUMATIC - CONTROLLED LOCK FOR CENTRIFUGAL - EXTRACTOR COVERS. William Bartholomew and Fritz Balzer, Chicago, Ill.

1,111,055. PROCESS OF REGENERATING AIR. Hector R. Carveth, Niagara Falls, N. Y.

1. The process of regenerating air consisting in passing the exhaled air in a closed circuit first over a regenerating agent, then over a hydrating agent and then over a regenerating agent.

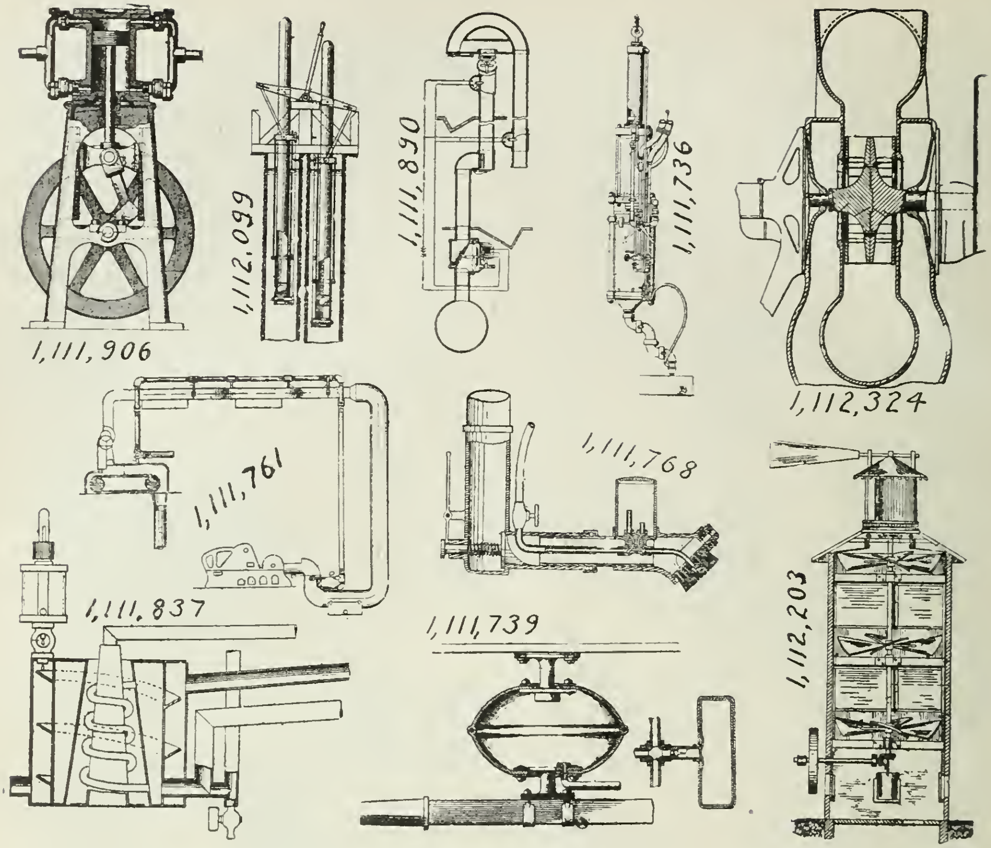
1,111,160. ROTARY BLOWER. Bertinius Larsen and Walter H. Parkin, Niles, Mich.

1,111,247. COMPOSITION FOR FORMING EXPLOSIVES WITH LIQUID OXYGEN. Georges Claude, Paris, France.

1. A composition for forming explosives with liquid oxygen, comprising a combustible metallic substance yielding by oxidation innocuous products of combustion, and a light inert substance acting as a solid diluent, the amount of the metallic substance in one liter of the composition being chemically equivalent to from one to six hundred grams of powdered aluminium.

1,111,335. FUEL - OIL - DELIVERY SYSTEM FOR MOTOR-VEHICLES. Alfred E. Walden, Detroit, Mich.

1. The combination with a main tank, of an auxiliary tank at a higher level, a delivery conduit from said main tank to said auxiliary tank, means for supplying air under pressure to said main tank to elevate the oil therefrom to the auxiliary tank, and means controlled by the level of the oil in the auxiliary tank for regulating the air pressure.



Pneumatic Patents September 29.

1,111,493. AUXILIARY REGULATING DEVICE FOR PRESSURE-REGULATORS. Peter J. Quinlan, Marietta, Ohio.

1,111,498. TURBO-BLOWER. Max Rotter, Milwaukee, Wis.

1,111,520. OIL-BURNER. Archie M. Baird and Harvey D. Palmer, Topeka, Kans.

1,111,556. AUTOMATIC AIR-SUPPLY SYSTEM FOR AUTOMOBILES. William C. Bakels, Midland Park, N. J.

1,111,633. DUST-CATCHER FOR AIR-PIPES. John W. Young, Memphis, Tenn.

1,111,675. AUXILIARY PNEUMATIC SUPPORT FOR VEHICLES. Philip Rayson, Elsternwick, Victoria, Australia.

1,111,683. STARTER FOR INTERNAL-COMBUSTION ENGINES. Simon S. Sutton, Eldorado, Ill

SEPTEMBER 29.

1,111,736. PROCESS OF FILLING MOLDS AND THE LIKE. Ira L. Conkling, Philadelphia, Pa.

1,111,739. SHOCK-ABSORBER. Benjamin W. Davis, Phillips, Wis.

1,111,761. ART OF CLEANSING COTTON AND PREPARING IT FOR MARKET OR FOR CARDING. John F. Reardon, Millville, N. J.

4. The herein described method of treating cotton and the like, which consists in conducting the cotton through a chamber or casing whose sides confine it against escape, and dispersing said cotton by discharging jets of compressed air against it.

1,111,768. CLEANING APPARATUS. Ira H. Spencer, Hartford, Conn.

1,111,778. VALVE MECHANISM FOR PNEUMATIC PLAYERS. Eugene T. Turney, New York, N. Y.

1,111,837. HUMIDIFYING APPARATUS. Arthur R. Joyce, New Fairfield, Conn.

1,111,890. PNEUMATIC - DESPATCH - TUBE APPARATUS. Edmond A. Fordyce, Boston, Mass.

1,111,906. AIR-PUMP AND VALVE THEREFOR. Jesse Keppel, St. Louis, Mo.

1,112,054. AIR-COMPRESSOR. Leroy Clawson, Hall, Mont.

1. A fluid compressing apparatus comprising axially alined cylinders, pistons working in said cylinders, valves carried by the pistons, a piston rod common to said pistons, a check valve slidably mounted upon a rod between the pistons and in frictional engagement with the rod, and means on the cylinders to limit the movement of the check-valve.

1,112,066. GAS AND AIR MIXER. Thomas H. Hollis, Pittsburgh, Pa.

1,112,099. BALANCED AUTOMATIC AIR-LIFT. Norman R. Smith, Red Bluff, Cal.

1,112,203. ATMOSPHERIC POWER-GENERATOR. Albert J. Fandrey, Indianapolis, Ind.

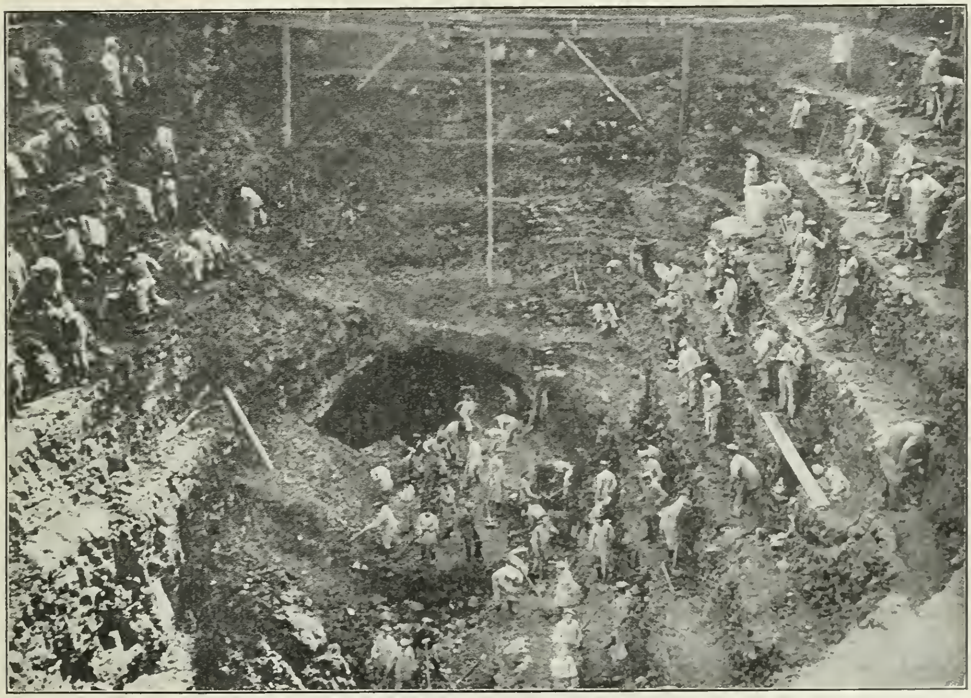
1,112,324. IMPELLER FOR CENTRIFUGAL COMPRESSORS AND PUMPS. Richard H. Rice, Lynn, Mass.

1,112,334. PISTON FOR PNEUMATIC SMOKERS. Bruce A. Shaw, Oak Park, Ill.

1,112,398. ROCK-DRILL. Daniel S. Waugh, Denver, Colo.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol XIX DECEMBER, 1914 No 12



GERMAN SOLDIERS DIGGING OUT A TUNNEL.

WAR ENGINEERING

Without the engineer the World War would have been impossible, which fact for the moment suggests some doubts as to the ultimate beneficience of the profession. But in peace as well as in war we cannot live without him, so that, whatever is going on, he is as sure of his job as the butcher or the baker, and no matter what the task he finds a way to do it.

The half tone above reproduces what must have been, under the circumstances, an excellent photo, and though it has suffered from a repeated reproduction it still tells its story better than any words. We are not permitted to know the exact location of it, but it happened that a correspondent of the *New York Times* passed the spot in going from the German Great Headquarters along a main line of communication through eastern France, across a corner of Belgium and so on through Luxemburg. The French had blown up, or blown in, a two track railway tunnel and the German soldiers were digging it out.

The writer on the spot tells us: "One track has been cleared but the going is still bad. To keep it from being blocked again by falling debris the Germans have dug clear through to the top of a hill, opening up a deep well of light into the tunnel. Looking up you see a pioneer company in once cream-colored, now dirt-colored fatigue uniform still digging away and terracing the sides of the big hole to prevent slides." The terracing spoken of was to give standing room for the successive tiers of shovelers.

The correspondent's story continues :"Half an hour later we go slow again in crossing a new wooden bridge over the Meuse—only one track as yet. It took the Germans nearly a week to build the substitute for the old steel railway bridge where five spans lie buckled up in the river. The pioneers are at work driving piles to carry a sceond track. A forty-man-power pile driver is rigged on the bow of a French river barge, with forty soldiers tugging at forty strands of the main rope." Further along a new branch line is being built, "You half expect to see a swearing Irish foreman. It looks like home—all except the inevitable officer (distinguished by revolver and field glass) shouting commands." There is no end to the story and no rest night or day.

A TUNNEL PAYS THE COST OF ITS OWN CONSTRUCTION

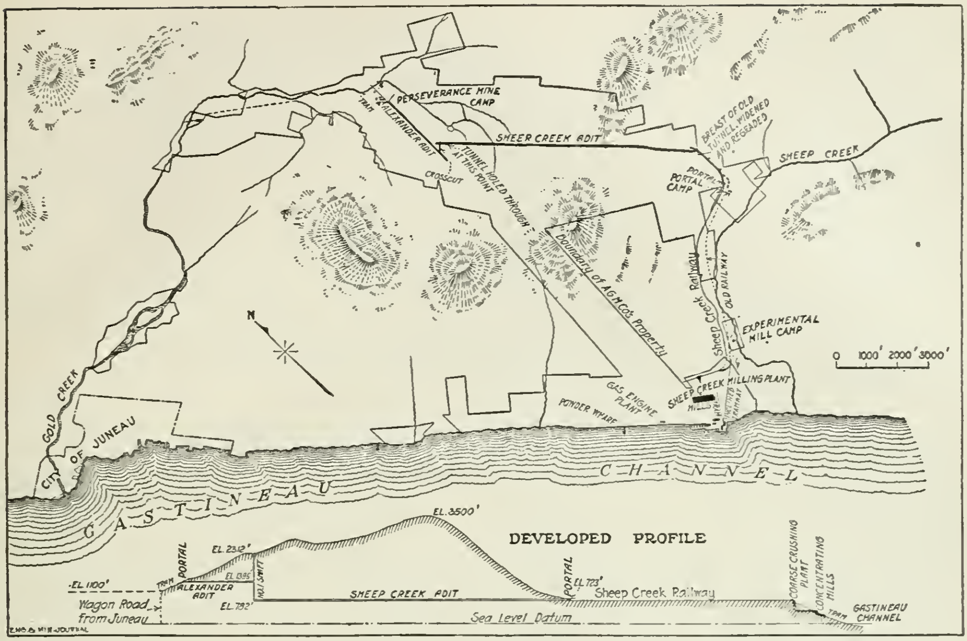
On October 29th the Mayor of Baltimore diverted the flow of Jones Falls, a small meandering stream running through the heart of Baltimore, into a tunnel built in conjunction with what is known as the Fallsway, thus forever burying an old open sewer, which has been an eyesore to the city. The remarkable feature of the improvement is that though it cost two million dollars and is for general public use, and not for a restricted measured service that can be charged for, it will eventually cost the city nothing. The increased taxes derived by the city from the creation over the stream of a new north and south street, running from the heart of the business district to the railroad depots, affording a traffic artery on easy grades, will pay the interest on bonds necessary for its construction and create a sinking fund to redeem them. The back lots of the properties backing on the old stream have been converted into valuable, desirable lots for business purposes facing this broad new boulevard. The work is a marked tribute to the man who conceived it, Calvin W. Hendrick, and is suggestive of possibilities in other cities. Had the stream been a wide one, with good water depth throughout the year, the improvement of its shores for shipping or for recreational purposes would have been advisable. Jones Falls, however, had a depth of water only in the spring, and for the rest of the year was a series of puddles. Under these conditions its conversion into a highway beneath which are three channels for carrying the flow was a most happy solution for ridding the town of a physical deformity.—*Engineering Record.*

POTASSIUM AND POTASH

The U. S. Geological Survey gives out the following to meet the numerous inquiries concerning the exact meaning of the terms "potash," "actual potash" and "potassium."

The element potassium, represented by the symbol K, is the basis of all potash salts or compounds. This substance is a metal; that is, it possesses metallic properties. To prevent rapid change it must be kept from air and water, with both of which it combines with great avidity. Combined with oxygen it forms potassium oxide, represented by the symbol K_2O, known as potassa, but popularly as "potash." In estimating the quantity of potassium in the different products of the Stassfurt deposits, this compound, K_2O, is employed as a standard, the object being to establish a basis of comparison for all potassium salts. Among chemists as well as laymen there has grown up the practice of using for this standard the term "potash." When only the term "potash" is used in speaking of potash products, it is understood to refer to the potassium oxide (K_2O) present. As a matter of fact, however, potash salts are not sold in the form K_2O, but as the sulphate or the chloride. By the term "potassium sulphate" is meant potassium (K) combined with the acid radicle of sulphuric acid (SO_4), or potassium oxide (K_2O) combined with sulphur trioxide (SO_3), making the compound K_2SO_4. By "potassium chloride" is meant potassium (K) combined with another element, chlorine (Cl).

The boilers of the U. S. battleship Nevada, recently launched, of the oil-fired Yarrow type, are to carry 295 lb. gage pressure.



PLAN AND PROFILE OF TUNNEL AND CONNECTIONS.

DRIVING SHEEP CREEK TUNNEL

The following is an abstract of a remarkably able and satisfactory report of an unusually interesting tunneling operation in Alaska. The report was prepared by the engineering staff of the Alaska Gastineau Mining Company and communicated to the *Engineering and Mining Journal* by the managing director of the Alaska Gold Mines Company, and the excellent abstract which appeared in that publication is here presented in a still more condensed form:

The Sheep Creek tunnel was part of the development program of the Alaska Gastineau Mining Company, at Juneau, Alaska. The Alaska Gastineau is the operating company of the Alaska Gold Mines Company. The tunnel was driven to develop the lode, and to form part of the transportation system between the mine and the 6,000-ton mill under construction on the shore of Gastineau Channel.

The portal of the tunnel is 723 ft. above sea level and 7,250 ft. distant from the coarse-crushing plant of the mill. Its underground terminal is its intersection with the main or No. 1 shaft of the Perseverance mine, 1,530 ft. below the surface and 613 ft. below the Alexander level, previously the lowest working adit on the Perseverance property.

A good deal of preliminary work was necessary before the actual driving of the tunnel was begun. A camp with warehouses, etc., was established on Gastineau Channel. From this point a 2,200-ft. inclined tramway connected at an elevation of 650 ft. with an old narrow-gage railroad or tramway, which ran along the side of Sheep Creek Basin to the old mine. This railroad was built entirely on trestles which had to be strengthened and rebuilt.

THE TUNNEL CAMP.

A camp was established at the end of the narrow-gage railroad near the entrance to the tunnel. There was a three-story rooming house, 20x66 ft., and a one-story mess house, 24x66 ft., containing dining room, kitchen, storeroom and in the basement a room for the fire-fighting apparatus. A third building was used for a change room on the lower floor and a club room on the second. The change room was equipped with steam-heated lockers, bathrooms, shower baths and lavatories. The club floor had a reading room, writing room, card room and assembly room. The central heating plant was located in the power house. The tunnel foreman had a cottage, and another small building provided sleeping quarters for the cooks and mess-house help.

The blacksmith shop was 24x50 ft., equipped with two forges, one No. 5 Leyner-Ingersoll sharpener, benches, tools, etc., and an air hammer made from a 3¼-in. piston machine. The carpenter shop was 12x24 ft Adjacent to the two shops was a storeroom, 12x30 ft., for spare drill parts, fittings and miscellaneous supplies.

The powder magazine was on the railroad track about one-half mile from the tunnel. An auxiliary magazine and thawer was situated about 150 ft. from the tunnel entrance with which it was connected by a covered passage. All powder was thawed in the original boxes by electricity and was taken to the face in the same boxes, except that made into primers; the primers were made up in this auxiliary magazine.

COMPRESSORS, DRILLS AND VENTILATING SYSTEM.

The compressor was an Ingersoll-Rand, Imperial, type 10, cross-compound, 22 and 13x16-in. machine, belt driven by a General Electric, form K 200-hp., 2,200-volt induction motor. The air left the receiver at 105 lb. and was carried in 7-in. casing pipe for about half the distance to the end of the tunnel and in standard 6-in. for the remainder. Flange unions were used throughout to facilitate making connections.

An exhaust ventilating system was used. The first fan placed just outside the tunnel, was a No. 5, Type K, American Blower Co. exhaust machine, belt-driven by a 20-hp. motor at a speed of 3,000 r.p.m., and delivering 3,000 cu. ft. of free air per min. against a 12-oz. pressure. At 3,000 ft. in a second fan, built by the Lewis Burton Co., was installed in series to handle the same amount of air against an 8-oz. suction; it was belt-connected to a 15-hp., 1,740-r.p.m. induction motor. At intervals of about 2,550 ft., additional fans of the same size and type were installed. A 15-in. ventilating pipe was made up of 18-gage galvanized iron in 25-ft. lengths. The lengths were provided with slip joints with lugs for wiring them together; all joints were wrapped with tarred canvas to insure their being air-tight. The series operation of the fans was intended to eliminate the necessity of heavy pipe to resist collapse, and also to reduce the leakage along the line.

The drills were Ingersoll-Rand E 44, 3¼-in. piston machines. Six were kept on hand, four at the face, one in the tunnel and one in the shop being overhauled. In use they were mounted on 4½-in. horizontal bars 9 ft. long. Of the drill steel the starters were made of 2-in. cruciform, with 2¾-in. gage, 32 in. long. The seconds were of 1¾-in. cruciform, with 2½-in. gage and 52 in. long; the last three pieces were made of 1½-in. steel, gages $2^{5}/_{16}$-in., 2⅛-in. and $1^{15}/_{16}$-in., length 74-in., 94-in. and 116-in. About 750 pieces were kept up, sharpening being done on the day shift only and over 500 pieces frequently being dulled per day.

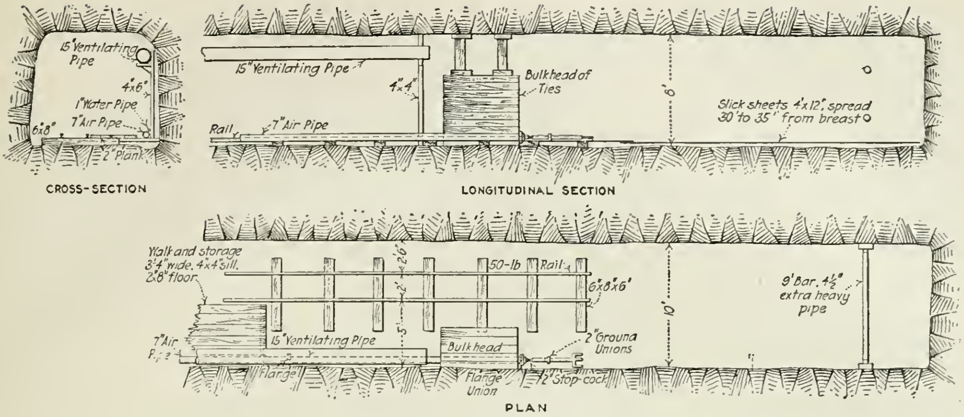
FEATURES OF THE TUNNEL.

Of the total tunnel length, 474 ft. was driven through slide rock and gravel near the portal; 4,009 ft. in greenstone, 4,224 ft. in slate and 1,085 ft. in metagabbro; the last three rocks alternated, the stretches varying from a few feet, up to several thousand.

In general the direction of the tunnel followed the strike of the formation, making it difficult to break the rock, especially the hard silicified slate, where the effect of the cleavage planes was marked. The holes broke short and a great many were required. Greenstone also developed cleavage planes in places with a similar result. When the tunnel was in homogeneous blocky greenstone, the rate of progress jumped to about a foot per hour, and there is no doubt but that if the entire distance had been driven in such rock, the record made would have been improved by at least 25 per cent., and the costs correspondingly reduced. In general, shallow rounds giving an average advance of 4 ft., were found to be most economical and rapid.

The tunnel was 10 ft. wide and 8 ft. high, with a small ditch along one side. Timbering was necessary only in the loose ground near the portal, and at this point the section was kept 8x10 ft. inside timbers. From the solid rock face from which the main tunnel started to its intersection with the crosscut from the Perseverance shaft, the distance is 8,800.5 ft.; 240 ft. of branch tunnel was also driven by the same crew. The relations of the different parts of the tunnel, as well as surface construction, are shown in the accompanying map and profile.

The tunnel was driven for single track its entire length, with the intention of widening out for sidings later. The average upgrade from the entrance was 0.65 per cent., based


CROSS-SECTION

LONGITUDINAL SECTION

PLAN

SECTIONS AND PLAN OF HEADING ARRANGEMENTS.

on questions of drainage and equalization of tractive effort with loaded and empty cars.

FORCE EMPLOYED AND SHIFT ARRANGEMENT.

The force employed consisted of 70 men. Working on day shift only, there was a general foreman, a time-keeper, a tool sharpener, tool-sharpener helper, a blacksmith, a blacksmith helper, a carpenter, an electrician, a powderman, and an outside man. Two compressor men worked 12-hr. shifts each. Divided into three shifts there were three shift bosses, 12 upper-bar machinemen, 12 lower-bar machinemen, 18 muckers, three carmen, three locomotive engineers, three locomotive brakemen and four pipe- and trackmen.

The arrangement of shifts was unusual. The cycle was completed in 18 instead of 24 hr.; during this time each of the three crews into which the force was divided worked 6 hr. and rested 12, so that in each 24 hr. there was 8 hr. of work for each man. The incoming shift would relieve the outgoing shift at the working face and there was no intermission in the work for the purpose of eating a meal; this eliminated the delay of the meal time and the slackening of work following heavy eating. The plan was eminently successful and acceptable to the men; the only objection was the complication in the meals at the boarding house; eight meals had to be served every 24 hr., two for each 6-hr-shift; each shift got a meal about three-quarter of an hour before it went on and another when it came off.

ROUTINE OF DRILLING.

After spitting the round, the men walked back in the tunnel about 1,000 ft. The holes were counted and immediately after the last lifter went off the men started toward the face again. The fans being in full operation continuously, no smoke was encountered until within about 60 ft. of the face. One man then carried to the breast a water hose, previously connected to the water line and sprayed the muck. Meanwhile the manifold was connected to the air line and the air hoses attached thereto. The top bar was next brought up and jacked into place; two machines were placed on the bar, the air hose connected as soon as possible and drilling started. At the beginning of tunneling operations it required about 30 min. from the time the last lifter was fired until the top-bar machines were running. By the end of the undertaking, this took frequently only 10 min. and seldom more than 15.

With the top machines in operation, the four lower-bar machinemen started mucking out to make room for the lower bar. They threw back to the slick sheet, from which the muckers loaded into the cars. It was usually possible to set the lower bar and finish drilling the lower holes by the time the top machines were finished, so that all of the machines were torn down together.

ROUTINE OF MUCKING.

While the machines were being placed in position, mucking began. The empty car was brought ahead and the track cleaned up to the slick sheet. Of the six muckers, four were shoveling continually and two resting. The average output of the force was 10 to 12 tons per hour. On a slick sheet beside the track, within 50 ft. of the face at all times, an empty car was kept. Whenever a car was loaded, the carman took it down the track and brought back the empty. There was thus only a fraction of a minute lost in changing cars. A few hundred feet back from the face another slick sheet was maintained and when the locomotive brought in a train of empties, they were thrown off the track on this sheet. The loaded cars were run back to this point, made up into a train and hauled out. From this latter sheet, the empty cars were run one at a time up to the sheet near the face. The empty cars weighed about 1,100 lb. and were hauled by a man using a crowbar. The sheets were kept about the same height as the top of the rail so that the car required to be lifted only the height of the flange. No switches were used anywhere. At no time did the removal of the muck limit the speed of drifting or interfere with the drilling cycle.

The steel plates used for the slick-sheet sidings were ¼x48x140 in. The siding some distance from the face was 48 to 60 ft. long; directly opposite it were ¼x22x140-in. sheets, resting on planks down the center of the track, and also flush with the rail heads.

TRACK-LAYING.

After practically all the muck was cleaned out, the shovelers laid ties to grade as the tunnel advanced, thus facilitating the subsequent laying of the rails. A 25-ft. false track was advanced over the ends of the rails as necessary, so that the cars were always next to the muck pile. When the advance permitted the insertion of a set of rails, the foreman and muckers did the work in 15 to 20 min., without disturbing the machinemen.

BLASTING

On the completion of the round, shovelers, machinemen and everybody helped to tear down the machines and bars. Then ¼x36x140-in. slick sheets were spread out for 30 ft. back from the face and covered with a little muck. These sheets were handled with grappling hooks through holes in each corner. When the machines were removed, an air hose was attached to a blow pipe and the holes cleaned. The shift boss, machinemen and foreman then did the loading. Double fuse was used on the lifters. The explosives were Bear Brand fuse, California 8X caps and Hercules E. L. F. extra 60 per cent. powder. Spitting the fuses completed the cycle. There is no relation whatever between the shift and the drilling cycle, the machinemen relieving each other without stopping drilling.

Operations	Time Consumed Min.
Returning to face	4
Setting top bar	6
Mounting and starting up two machines	3
Shoveling back for bottom bar	30
Drilling 20 to 25 holes	210
Tearing down machines	5
Blowing out holes	4
Loading holes	6
Cutting and spitting fuses	2
Interval to report of first hole	4
Interval from report of first hole to report of last	3
Total	4 hr. 37 min.

Beginning with the time the last hole was heard to explode, the average time schedule for the last five months' operations would be about as follows:

THE ROUND.

In drilling the round the standard center cut, generally with six holes, was used; these cut holes varied from 7½ to 8 ft. The side holes and lifters, which averaged 5½ ft., were put in to suit the ground. Variations in the nature of the formation necessitated a good deal of variation in the layout of the holes. A good many relievers and "kickers" were frequently necessary. The usual round required 21 to 23 holes, although at times 29 were necessary. For a 22-hole round the total footage was about 140; the average rate of drilling dry holes was 6 ft. per hr., of drilling wet holes, 7 to 10 ft. per hr.; the average time for a complete round was 3½ to 5 hr.; the average advance per round was about 4 ft.

TRAMMING.

The muck from the face was hand-trammed at first, subsequently a storage-battery locomotive was used, transporting material, men and waste rock. The Matheson side-dumping roller-bearing cars had a capacity of 30 cu. ft. Drill steel and miscellaneous material were handled principally on small flat cars. The 30-ft. capacity cars were the largest that could be used on the slick-sheet sidings. They were loaded heaping full, since when loaded they did not require to be derailed. The track gage was 24 in., the widest for which the side-dump cars could be built and allow the loaded car on the track to pass the empty on the siding.

At the beginning of operations, the locomotive hauled out 12 cars in a train, but as the length of the tunnel increased, it became necessary eventually to handle trains of 30 cars.

PIPE TRACK AND WIRING.

The ventilating pipe was carried on 4x6-in. vertical posts spaced 15 ft. It was kept close to the face and protected by a bulkhead of ties.

TABLE I. COMPARATIVE DATA FROM AMERICAN AND EUROPEAN RECORDS.

Name of Tunnel	Size in Ft.	Character of Rock	Progress for Entire Length: Average Monthly Advance in Ft.	Progress for Entire Length: During Months	Progress over Long Periods: Average Monthly Advance in Ft.	Progress over Long Periods: During Months	Best Monthly Record, in Ft.
Sheep Creek	8x10	Greenstone and slate	544.2	16	596	6	661
Loetschberg, Switzerland	6x10½	Limestone and gneiss	490	54	683	18	1013
Simplon, Switzerland	6½x9½	Schist	. . .	. .	. . .	. .	685
Arlberg, Switzerland	8⅓x9⅓	Gneiss	474	36	. . . .	.	641
Tauern, Austria	. . . .	. . . .	. . . .	.	525	11	548
Laramie-Poudre	7½x9½	Granite	473	19	525	12	653
Strawberry, Utah	9x11	Limestone	. . . .	. .	426	11	492
St. Louis Waterworks	10 ft. diam.	Limestone	430	5¼	. . . .	. .	745
Arizona Copper Co.	8x8	Porphyry	. . . .	.	669	3	799
Rawley, Colo.	7x8	. . . .	. . . .	. .	358	17.4	. . .
Mammoth, Calif.	8½x9½	. . . .	. . . .	. .	316	9½	395
Roosevelt, Colo.	6x10	. . . .	. . . .	. .	292	12	435
Mt. Royal, Montreal	8x12	Limestone	. . . .	. .	. . .	.	810
Gunnison	6x10½	Soft limestone	. . . .	. .	. . . .	. .	824
Los Angeles Aqueduct	12x13	Black shale	. . . .	. .	.	. .	604
Los Angeles Aqueduct	12x13	Cemented sand	. . .	. .	. . . .	. .	1061

A compressed-air line was carried along the bottom on 4x4-in. sills, which also supported the board walk; the end of this pipe was protected by the same bulkhead. The main line was always thus within a hose length of the face. An extra manifold was kept on hand and when it was necessary to extend the pipe line, this manifold was attached to the new length of pipe before the latter was put on; this considerably facilitated the operation.

The rails used were 50-lb. and were laid on 6x8-in. by 6-ft. ties. When the track is widened to its permanent gage of 36 in., one rail only will be moved.

Six wires were carried the length of the tunnel; three of these were used for the single-phase, 110-volt lighting system, the purpose of the third wire being to give equal voltage at all points in the tunnel. The other three wires constituted the three-phase, 440-volt alternating circuit for the ventilating-fan motors.

SPEED OF ADVANCE.

Drilling was started November, 1912, but the work was not considered as completely organized until December, 1912. Between December 1, 1912, and April 1, 1914, a period of 16 months, the tunnel was advanced 8,707 ft. with a single heading, an average of 544.2 ft. per month. During the last six months, the average monthly advance was 596 ft. The greatest monthly advance was 661 ft. made in November, 1913. At various times advances of 24 ft. per day were made. It is believed that this constitutes the world's record for sustained progress in extremely hard rock with an 8x10-ft. tunnel section. Monthly records have been made considerably in excess of 661 ft., but we know of no record equals that of 596 ft. maintained for six which equals the average advance of 544.2 ft. over the entire period of operation covering 16 months and of no American record which months. Tables I and II present data covering this point.

TABLE II. SHEEP CREEK AND LOETSCHBERG TUNNELS.

	Sheep Creek	Loetschberg	Ratio
Size of tunnel, ft.	8x10	6x10½	
Area of cross-section, sq.ft.	80	63.5	1.26 : 1
Best monthly record, ft.	661	1013	1 : 1.53
Record on entire length, ft.	544.2	490	1.1 : 1
Average progress per round, ft.	4	3.97	
Average length holes, ft.	6.37	4.54	1.4 : 1
Number of holes per round	22	13.4	1.64 : 1
Total footage holes per round	140	61.3	2.28 : 1
Drilling time per round, hr.	1.58	4	1 : 2.53
Drilling time per ft. of hole, min.	1.72	1.55	1.1 : 1
Entire duration one round, hr.	5.3	4.48	1.18 : 1
Strength of dynamite used	60%	85%	
Pounds used per ft. advance	34	15.5	
Number of drills used	4	4	
Support for drills	Horizontal bars	Carriage	

WAGES AND BONUS.

On account of the peculiar shift arrangement, the men were paid by the hour, and in addition a bonus was distributed. The wages were as at top of next column.

A bonus was paid as follows: For 300 ft. per month or under, no bonus; for 300 to 350 ft. per month, $7 per ft. for the 50 ft.; for 350 to 400 ft. per month, $8 per ft. for the

Machinemen, muckers and carmen	$0.50
Shift bosses	0.58
Blacksmith	0.60
Tool sharpeners	0.50
Tool-sharpener helpers	0.40
Blacksmith helpers	0.35
Compressor men	0.40
Electricians	0.50
Timekeepers	0.45
Carpenters	0.60

50 ft.; for 400 to 450 ft. per month, $9 per ft. for the 50 ft. This increased $1 per ft. for every additional 50 ft.

The foreman distributed the bonus according to his judgment. It was his practice to give the lower-bar machinemen $30 a month bonus, independent of the total amount received. The muckers, carmen and motormen each received $10 to $15 per month bonus at the foreman's discretion. The tool sharpeners received $45 per month bonus. The amounts noted above were deducted from the total bonus of any one month and the remainder divided equally among the top-bar machinemen and the shift bosses. His idea was to give the greatest reward and the greatest incentive to the men chiefly responsible for the rate of progress. The result was thoroughly satisfactory.

NECESSITY FOR HIGH SPEED.

The development of the Alaska Gastineau property involves the expenditure of an extremely large sum. It consists of several different elements, and economy requires that these be completed as nearly as possible at the same time. Driving the tunnel was the work which involved the greatest number of contingencies and unknown factors. It was, therefore, imperative that it be completed in time, and for this reason the high speed of driving was aimed at. More important, however, was the fact that by pushing the tunnel through rapidly, it became available for development work by raises which otherwise would have had to be done by sinking, and the raising cost is only about one-third of the sinking. The tunnel was also made available for handling a considerable amount of muck, 300 tons, which otherwise would have required hoisting to the Alexander level and dumping on a hillside where room was limited. There is no doubt but that the tunnel could have been driven more slowly at a lower cost per foot, but the indirect economies mentioned would not have been obtained.

COSTS.

The following cost data apply to the 8,707 ft. driven between Dec. 1, 1912, and April 1, 1914, this representing the distance driven under the standard conditions described:

Wages	$14.72
Bonus	4.14
Explosives	4.47
Lighting	0.28
Tool replacement	1.35
Lumber and miscellaneous supplies	0.75
Store expense and transportation	0.38
Power and compressed air	2.53
Loss on boarding house	1.17
Depreciation on mining tools	1.29
Total	$31.08

A $1 charge per man per day for board did not cover the cost, inasmuch as the food was of high class and expenses of transportation and help were excessive. Nearly all the men ate four meals per day. Under "power and compressed air" is included the operating expense of furnishing the compressed air and of ventilating. The labor of installing pipes is included, but not the cost of the pipes themselves, since this became permanent equipment.

It is believed that the excellent results obtained in driving this tunnel were due to the following factors: (1) The energy and skill of the foreman, P. H. O'Neill; (2) the bonus system; (3) efficient ventilation; (4) the elimination of switches in the tramming system; (5) the excellent equipment and the large supply of spare parts kept on hand.

DIVING SERVICE ON THE PANAMA CANAL

If a ship passing through the canal require the services of a diver such service is always ready. The rates quoted below are effective for the following services furnished individuals, companies, and others, according to an announcement by Gov. Goethals, of the Canal Zone:

For service of a diver, his assistants, and apparatus, for the first four hours or fraction thereof, from time of arrival at point of diving	$60.00
For each succeeding hour or fraction thereof	10.00
Compressed air, per 1,000 cubic feet	.12
For giving cable notice of deposits with the Treasurer or Assistant Treasurers of the United States to be applied in payment of tolls, material, supplies, and services	5.00

FREIGHT TUNNELS FOR NEW YORK

No man could have been suggested more fully qualified to discuss the harbor needs of New York, especially as to the reception, transmission and distribution of freight than Mr. T. P. Shonts, former Chairman of the Panama Canal Commission, and now President of the Interborough Metropolitan Company, and this he has done in a marvellously comprehensive way in a recent Sunday issue of the New York Times. He first discusses the inadequate and unsatisfactory "facilities" now existing. He says there are daily standing on the railroad tracks about New York from 4,000 to 6,000 cars, awaiting the opportunity to discharge their contents and return to normal trade channels. This means that an investment in cars alone of from $4,000,000 to $6,000,000 is lying idle, because the facilities of the Port of New York are inadequate even with the business at present being done, and the situation will not be relieved until ferries, car floats, and lighters shall be superseded by a continuous freight movement through river tunnels. The natural location for great railroad yards to handle, assemble, and classify all this traffic is the Hackensack Meadows in New Jersey.

IMPORT AND EXPORT TRAFFIC.

The matter of exchange of traffic between the railroads and the water carriers brings up the question of a great import and export depot at Bayonne, N. J. It has been estimated that the terminal cost of handling a ton of "all rail" or "water and rail" freight at the Port of New York is as much as to move the same ton 300 miles on any of our trunk lines of railway. The waters of New York Harbor, which are continuously becoming more and more congested, divide the port into five grand divisions—Manhattan, the Bronx, Long Island, Staten Island, and New Jersey. The water front of Bayonne is the economic and geographic location for an import and export harbor. Piers 4,000 feet long could be extended into New York Bay without interfering with navigation, into which cargoes could be unloaded from ships into storage and then to cars, and vice versa, with the minimum of handling. With Bayonne as the exclusive import and export harbor of the Port of New York, there would be saved on 80 per cent. of her import and export tonnage the cost of floatage, and the congestion of her waterborne traffic would be relieved to just that extent.

LOCAL FREIGHTING IN GREATER NEW YORK.

The tunnel is the solution of New York's freight distribution problem. Tunnels may be built one after another, as needed. They may be located between points as and where changing future requirements may demand. Besides creating the shortest and most economical route between New Jersey and New York, the desirability of minimizing the number and length of necessary rail movements in the freight subway in Manhattan must be kept in mind.

With a bridge, traffic would have to come across the river concentrated through one fixed channel, which would mean that for all time freight, after reaching Manhattan, would have to be handled either in the subway or by an elevated structure for the full distance from Fifty-seventh Street to a southern terminus—say Cortlandt Street.

The tunnel is an entirely different proposition, however. Should the future density of traffic coming into Manhattan warrant it, communication between the shores of the Hudson could be carried on through a "battery" of tunnels. The volume of business could be split up by having one tube connecting up on the Manhattan side, say at Canal Street, to serve the tonnage zone between Canal and Cortlandt Streets; another at Fourteenth Street, to serve the zone between that and Canal; another at Twenty-third Street, to serve the zone between that and Fourteenth Street; another at Thirty-third Street, to serve the zone between that and Twenty-third Street, and so on as the requirements of commerce demanded.

With a freight subway on the west side of Manhattan, served by tubes under the Hudson River, logical extensions could be carried across Manhattan Island to another freight subway on the east side of the city, to be constructed, link by link, as occasion required.

The next logical extension would be under the East River into the great manufacturing and commercial centres of Brooklyn and South Brooklyn, thereby, incidentally, making the shortest possible direct connection between the railroads of New Jersey and New England (by means of a comparatively short line to the Connecting Railroad, now in process of construction) and linking up the distributing terminal facilities of the Port of New York into a honogeneous unit.

Upon the completion of the tunnels under the Hudson and across Manhattan into Long Island, the waters of the harbor would be relieved of the floating service now operated by the New Jersey railroads, and the water front given over almost entirely to modern piers for the exclusive accommodation of passenger steamers and the freight and express business they carry.

BRIDGE AND TUNNELS.

While the tunnel solves New York's freight-distribution problem, a bridge of suspension type over the Hudson is structurally feasible, and it is not improbable that at some future time both tunnels and a bridge will be necessary to meet the commercial requirements of New York—the bridge to form the connection with the great highways of vehicular and pedestrian travel of New Jersey, Manhattan Island, and Long Island, and the tunnels to accommodate the railway, freight, and passenger business, as well as heavy trucking traffic.

COMPARATIVE COSTS.

The greater expense of a bridge over that of a tunnel is a matter to be considered. The original estimate of the North River Bridge Company, which had a charter for a bridge opposite Twenty-third Street, but was compelled for reasons already mentioned to change its site to the neighborhood of Fifty-ninth Street, as to the cost of a structure of sufficient capacity to answer all purposes, including approaches, connections, and stations, complete, was between $90,000,000 and $100,000,000. More recent estimates made for a suspension bridge to meet all requirements including eight lines of rapid transit, two thirty-six feet wide driveways, and two eight-feet-wide sidewalks, place the cost at $42,000,000, as compared with an estimated cost of approximately $7,000,000 for a tunnel. That is, the cost of a bridge would be approximately equivalent to the cost of six tunnels.

Keeping in mind the fundamental thought that the railroads may be induced to pool their present properties, one is surprised, on studying a map of the port, to note how readily and at what relatively small expense existing railroad properties may be connected up; how short stretches of rail will unite the terminal lines in New Jersey with the great clearance yards to be established in the Hackensack Meadows; how another short stretch to Bayonne will link them up with the great import and export depot to be built there; how a tunnel or tunnels under the Hudson will connect with a subway up and down, say, Eleventh Avenue, and switches run to such piers as the traffic necessities of the city indicate ought to be reserved for each particular freight zone; how an extension of the subway across Manhattan to one alongside the East River, with switches to piers on that water frontage, will link up with a tunnel under the river to tap the nucleus of a series of belt lines to be extended indefinitely through Brooklyn and Queens—which two boroughs are the natural field for an unlimited development of the city's manufacturing industries for generations to come.

The above, we are well aware, is an entirely inadequate presentation of the valuable paper of Mr. Shonts, but it is all that our space will permit. The paper should be studied in its entirety by those interested.

OUR EXPORTS AND IMPORTS

The world's leading importers are the United Kingdom, Germany and the United States, in the order named, France being fourth and the Netherlands fifth. The United States and the United Kingdom are the world's largest exporters, followed by Germany, France and the Netherlands. The United States furnishes about 20 per cent. of the total imports into the United Kingdom, 15 per cent. of those into Germany, 10 per cent. into France, 14 per cent. into Italy, 65 per cent. into Canada, 53 per cent. into Cuba, 50 per cent. into Mexico, 15 per cent. into Argentina and 15 per cent. into Brazil.

The Commercial Relations of the United States, a volume of 272 pages, just issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce, contains revised figures showing in detail for the year 1912 compared with the previous year the articles entering into the trade of each country and the commercial transactions with the United States. This volume should prove valuable to those interested in the foreign trade of the United States and foreign countries. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 40 cents each.

GAS NOT EXPLOSIVE

The idea, still widely prevalent, that certain gases are explosive in themselves, is erroneous, as was proved in a very striking manner by Samuel Clegg at the installation of the first gas-house in London. To the consternation of the examining commission Clegg bored a hole in the wall of the gas-holder and ignited the issuing stream of gas. A long flame shot out, burned quietly, without the slightest explosion, until it was extinguished by the sinking of the gas-holder bringing the hole below the level of the surrounding water. When an attempt was made to blow up a Glasgow gas house with dynamite only the iron parts were shattered, and the escaping gas burned without explosion. In such cases the ignition of the escaping gas is a safeguard against explosion as it prevents the formation, in large quantities, of explosive mixtures of gas and air.

Even an explosive mixture can be prevented from exploding by the addition of an inert gas. This is of great practical importance because such an inert gas is available in large quantities in the carbon dioxide which constitutes from 8 to 14 per cent. of the chimney gas of steam boiler furnaces. Eitner and Trautwein have proved that any mixture of illuminating gas and air can be made inexplosive by the addition of 7½ per cent of carbon dioxide. This fact is utilized for the prevention of explosion due to the mingling of gas and air in the first filling of new gas holders and gas pipes. Furnace gas is blown through the system before the illuminating gas is admitted.

In even the most explosive mixtures explosion can be prevented by cooling below the temperature of ignition. A jet of such a mixture, issuing from a tube a diameter less than 1-12 inch, may be ignited without exploding the mixture inside the container, because of the cooling effect of the walls of the small tube. The construction of Davy's safety lamp for miners is based on this principle. The flame is inclosed in fine wire netting, which is equivalent to a multitude of small tubes. Fire damp (methane), if present in the air of the mine, enters the net and burns therein, without exploding the mixture of gas and air outside.

Some explosive mixtures of gases are usefully employed in heating by gas, in incandescent gas lighting, and in explosion motors. All gas heaters and incandescent burners operate on the principle of the Bunsen burner, which automatically mixes the illuminating or fuel gas, before combustion, with a quantity of air. In gas stoves this addition of air is made in order to produce a non-luminous flame, to prevent the blackening of objects exposed to the flame, and to assure complete and odorless combustion of the gas. These objects are the more perfectly attained the larger the proportion of air that is added to the gas. When illuminating gas at the usual pressure, however, is mixed with more than thrice its volume of air (a quantity insufficient for complete combustion) the velocity of efflux is less than the velocity of propagation of ignition, so that the flame "strikes back." The quantity of air added can be increased by increasing the pressure of the gas. This is especially advantageous in incandescent gas lighting where it is desirable to concentrate the combustion in a small space in order to produce a high temperature, and, consequently, an intense luminosity.

In explosion motors it is advantageous to use as little gas as possible, i. e., to approximate as closely as possible to the lower explosive limit. Richer mixtures (corresponding to the upper limit) cause violent explosions, which are far less completely utilized by the moving parts than the mild explosions and expansion produced by mixtures poor in gas. With some mixtures, especially hydrogen and air, these violent explosions may destroy the motor. The operation of explosion motors with very small quantities of gas or vapor is facilitated by the fact that the explosive range is considerably extended at the high temperatures and pressures that prevail in the interior of the cylinder. These principles have been utilized so fully in recent years that the motors of automobiles have attained a perfection that no one would have ventured to predict twenty years ago. This remarkable development is due to increased knowledge of the behavior of explosive mixtures of gas, and this knowledge has been acquired from practice, not from purely scientific researches. In this field practice is far ahead of pure science.

The railroad tunnel through the Cascade Mountains at the summit of Snoqualmie Pass, in Washington, 12,000 feet long, has been completed with the unusual and enviable record of "no lives lost."

PNEUMATIC CAISSON SCHEME FOR SUBAQUEOUS TUNNEL CONSTRUCTION

The difficulty and the cost of driving subaqueous tunnels through soft material by the now familiar shield method are sufficiently well known to engineers, special attention being directed to those which have been built and those which are to be built under the East River, New York city.

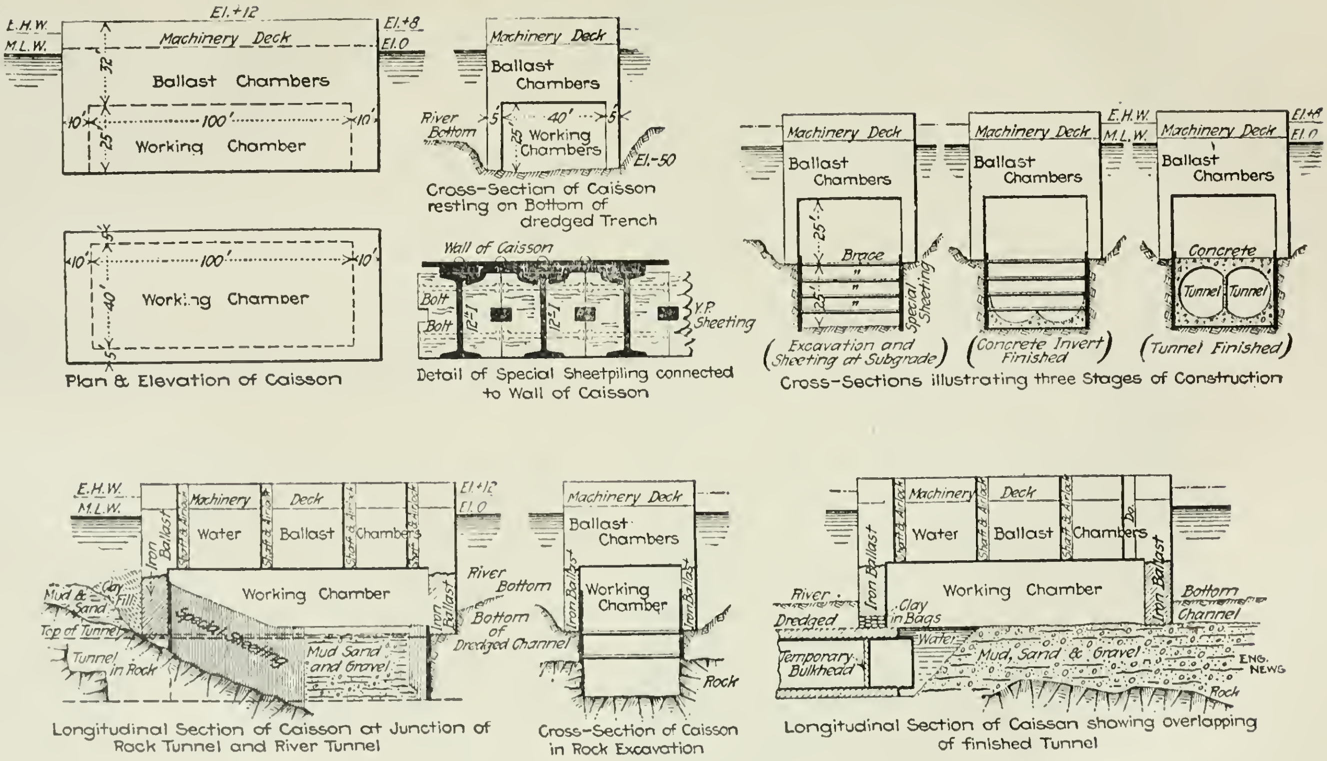
The fundamental cause of most of the troubles which have been experienced here is found in the difference in hydrostatic pressure at the bottom and at the top of a tunnel heading. Air pressure sufficient to keep the floor of a tunnel dry will be enough greater than the hydrostatic head at the roof of the tunnel to allow the air to escape in great volume; and when the cover is not sufficiently heavy, may even blow a hole through the river bottom and by thus suddenly reducing the air pressure in the tunnel allow the water and mud to enter the tunnel, resulting in a "blow-out." In practice this difference in pressure is kept as small as possible by keeping the air pressure in the tunnel about equal to the hydrostatic head at the middle of the tunnel section; but it is still greater than the hydrostatic pressure at the roof of the tunnel; and this difference in pressure is the chief cause of the delays and expense in building tunnels by the shield method.

An entirely different plan for tunnel construction under the conditions here encountered has been suggested by Mr. Emil Diebitsch, Vice-President of the John Peirce Company, 90 West Street, N. Y. City, who described his scheme in a comprehensive article in *Engineering News,* Oct. 22, 1914, what is here presented being an abstract of a small portion only of that article.

In the shield method the work of excavation and construction is carried forward in a vertical plane or heading under a condition of unbalanced pressures. In the method herein proposed the work is carried on in a horizontal plane under a condition of balanced pressures. The method in general consists of building successive lengths of the tunnel under the protection of a huge movable pneumatic caisson which rests on the river bottom and extends above the surface of the water like a dock or pier. When a section of the tunnel has been completed, the caisson is moved forward along the line of the proposed tunnel, so that another section of tunnel immediately adjoining the finished section and connecting with it may be constructed. By repetition of this process the entire tunnel between pierhead lines may be built.

This caisson is really a huge steel box with double walls inclosing ballast chambers, surrounding a working chamber decked over on top but open at the river bottom. Water is excluded from this working chamber by means of compressed air and access to it for men and materials is gained by means of shafts and air locks in the usual way. The word caisson is used to designate this steel box, but it should be noted that this structure differs in design and function from the caissons used for foundations of bridges and buildings. It does not permanently form the bottom of the finished structure as ordinary caissons do, but is used as a temporary protective covering placed over the portion of the tunnel under construction, and is moved to a new position as soon as the tunnel section is completed. This caisson rests on the river bottom above and at the edge of the excavation within which the tunnel is built. It therefore has no cutting edge but a broad base, giving ample bearing surface for stability and to prevent the caisson from sinking too deeply into the mud of the river bottom. To facilitate the handling of the caisson, it is provided with ballast chambers which can be readily filled or emptied of water by means of valves and pumps. These ballast chambers must be large enough to contain sufficient weight to hold the caisson securely on the river bottom when the tunnel construction is proceeding. Enough of the ballast should be water for easy handling, which, when pumped out of the chambers, will permit the caisson to float.

Reference to the accompanying drawings will show that the caisson under consideration has the following principal dimensions: Length 120 ft.; width 50 ft.; depth 62 ft. Length of working chamber 100 ft.; width 40 ft.; height 25 ft. The estimated weight without machinery or ballast is 2500 tons. This structure is large enough and strong enough to form when resting on the river bottom, a pier to which scows, lighters, tow boats, etc., may be moored and on which materials and supplies may be landed. The main deck of the caisson will be equipped with derricks, hoisting engines, concrete mixers and such other machines and appliances as may be needed for expeditiously



Plan & Elevation of Caisson

Cross-Section of Caisson resting on Bottom of dredged Trench

Detail of Special Sheetpiling connected to Wall of Caisson

(Excavation and Sheeting at Subgrade) (Concrete Invert Finished) (Tunnel Finished)
Cross-Sections illustrating three Stages of Construction

Longitudinal Section of Caisson at Junction of Rock Tunnel and River Tunnel

Cross-Section of Caisson in Rock Excavation

Longitudinal Section of Caisson showing overlapping of finished Tunnel

SKETCHES ILLUSTRATING A PROPOSED CAISSON METHOD FOR CONSTRUCTING SUBAQUEOUS TUNNELS and economically handling the excavated materials from the working chamber to the scows and the structural materials such as sand, gravel, cement, steel and lumber from the lighters to the air locks.

The machinery deck, located about 12 ft. below the main deck, will contain boilers, air compressors, steam engines, electric generators, motors, pumps and such other machinery as may be needed in constructing the tunnel or handling the caisson. The walls of the working chamber are provided with interlocking tongued-and-grooved poling boards or shutters which resemble sheet piling. These sheet piles are shown in the drawing as constructed of steel I-beams with grooved timbers bolted on each side of the webs of the beams. These sheet piles are used as vertical poling boards and are carried down a little in advance of the general excavation and serve to keep the air within the excavation from escaping too freely. They also sustain the banks of the trench within which the tunnel is built. It should be noted that each sheet pile is attached to the wall of the working chamber by means of bent steel plates forming a groove within which the sheet pile can readily be moved vertically up or down but which resists lateral displacement of the sheet pile.

Having constructed the caisson as above described with all necessary men and material locks, ballast chambers, etc., and equipped it with air compressors, boilers, pumps, dynamos and other necessary machinery, the procedure is as follows:

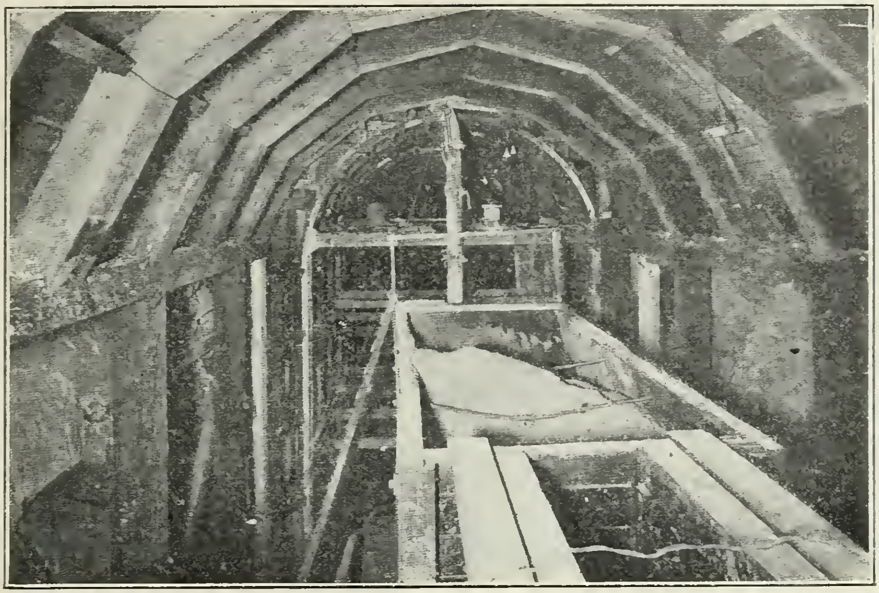
A trench is dredged along the line of the proposed tunnel, wide enough to hold the caisson when resting on the bottom of the channel and at least 45 feet below extreme low water, as the harbor regulations require the top of the tunnel to be below that depth. The caisson is towed to a point selected for beginning work and sunk by flooding the ballast tanks until it rests on the bottom of the channel. Compressed air is forced into the working chamber until all of the water is excluded, some of the water being pumped out if deemed more expedient, and more ballast is added in order to hold the caisson in place. Workmen now enter the working chamber and begin excavating, taking care to keep the sheeting below the excavation, and cross bracing the sheeting if necessary, as the excavation proceeds. When the bottom of the excavation is reached, concrete is placed to form the foundation and invert for the tunnel lining.

The tunnel can now be built as designed—whether of massive or of reinforced concrete with waterproofing of fabric and pitch or asphalt or brick laid in asphalt. Should it be found desirable to surround the tunnel with a metal casing to act as waterproofing, this can be made of thin steel plates or of sheet copper. When a section of the tunnel has been completed, the sheet piling must be drawn and secured to the walls of the working chamber after which the caisson is to be moved ahead.

The next step is to float the caisson by discharging ballast and to move it along the line until the rear end just overlaps the finished portion of the tunnel, thus allowing the end of the finished section to project into the working chamber. The caisson must now be sunk to the bottom of the channel in this position by flooding the ballast chambers, after which the work now proceeds as before.

These operations would serve for constructing the portion of the tunnel under the river, but provision must be made for connecting the river tunnels with the tunnels on the Manhattan and Brooklyn shores. A study of the boring sheet made by the engineers of the Public Service Commission for the new subway tunnels from Whitehall St., Manhattan, to Montague St., Brooklyn, for which contracts were recently let, show that approaching the Manhattan shore the rock in the river apparently rises sufficiently above the top of the tunnel to permit of driving a tunnel in the rock in the ordinary way. In this case the caisson could be located near the point where the tunnel enters the rock from the sand and mud in the river and a heading could be started into the rock from the working chamber of the caisson. If the rock is of such a character as to require compressed air to keep the excavation dry, or compressed air and a shield, the air could be furnished from the plant on the caisson and the tunnel driven toward the shore, using the caisson as a shaft. If on the other hand the rock is solid and the tunnel can be driven without air, it might be advisable to bulkhead the tunnel after it has been well advanced into the rock and drive the rest of the tunnel under normal air pressure from a shaft on the Manhattan shore.

On the Brooklyn shore, where the tunnel enters earth and sand below mean high water, it may be advisable to use a shield. The shield could be set up in the working chamber of the caisson and operated with the plant on the caisson, using the caisson as a shaft for men and materials.



DEPOSITING THE CONCRETE.

COMPRESSED AIR FOR LINING A TUNNEL

Compressed air is being used in lining the 800-ft. summit tunnel between Casper and Thermopolis, Wyo., on the new line of the Chicago, Burlington & Quincy Railroad connecting Thermopolis and Orin Junction. The tunnel was excavated a year ago in rather treacherous sandstone, which required timbering throughout its length. It is now being lined with concrete and the timber is being removed as the concrete lining is placed. Material for the concrete is brought in gondola cars from Casper, where the sand and gravel are dredged from the river.

Three operations constitute the work of lining the tunnel; these are first, the removal of timbers; second, the erection of the Blaw steel forms, and third, the mixing and placing of the concrete. The timbers are pulled down by a dinkey engine, cables fastened to the bottoms of the uprights passing through snatch blocks placed in the center of the track. When the posts are pulled out the debris is cleared away and the loose rock is picked down to insure the safety of the men erecting the forms. To protect the men further, planks are laid from the remaining timbers to the concrete to catch any small pieces of rock or give warning in case a large rock should fall. From 5 to 20 ft. of timber, depending on the condition of the rock, are removed at one time.

Erection of the forms consists of placing a steel channel rib, which fits the section of the tunnel, and connecting it with the last rib previously placed by means of steel plates 4 ft. long and 3 ft. high. These plates are built up solid to the top of the arch, as the concrete placed by the compressed-air method, allows the forms to be built complete before concreting begins. The steel ribs of the forms are 4 ft. apart, corresponding to the length of the plates, and from one to five sections are set up at a time, according to the length of timber removed.

THE OUTFIT.

The mixing and placing outfit consists of a pneumatic concrete mixer and conveyor mounted on a 40-ft. flat car, equipped with bins holding 26 cu. yd. of material. The cement is stored in bags under one of the bins and discharged toward the center of the car through chutes into a measuring hopper. This measuring hopper is lifted and tilted automatically to discharge into the mixer. The lifting device is a 6-in. air cylinder. The 8-in. delivery pipe leads from the mixer under the car and vertically up at the end of the crown of the arch, where a 90-deg. elbow enters through the bulkhead of the form. Air is supplied from a compressor at the mouth of the tunnel through a 4-in. main laid on brackets fastened to the timber posts, and a connection is afforded from the main to the air receiver on the car by means of a hose.

The proper size of compressor to run a portable outfit of this kind is believed to be about 300 cu. ft. capacity of free air per minute, compressed to from 80 to 100 lb. In beginning the work, however, a compressor of 134 cu. ft. nominal capacity was furnished by the railroad from one of its yards. The amount of air actually furnished by the compressor was approximately 80 cu. ft. per minute. This is thought to have reduced the output of the mixer and conveyor, and is mentioned because it applies to the data given below.

OPERATION.

The car is taken into the tunnel by means of the dinkey engine and spotted at a point next to the forms. The upper elbow of the delivery pipe is previously suspended in place so that when the car is "spotted" the upper pipe is bolted to the pipe on the car, which comes directly under it. The air connection is then made and concreting immediately begins.

The car is loaded by means of a portable derrick, which handles a wooden skip, as a clamshell bucket was not at first available. This wooden skip is loaded by several men shoveling the bank-run gravel into it, and is then lifted above the bins on the car and dumped into them.

The first work done by the outfit, which embraced the lining of the first 20 ft. of forms required five carloads of concrete material to fill the form. The entire work of tearing down timbers required 128 men-hours, the total time erecting forms was 229 1-2 men-hours, the time loading gravel and cement on the car required 140 men-hours and the total time required for mixing and placing the concrete in the forms was 204 men-hours. The total yardage placed was 132 cu. yd. From these figures it is seen that the number of men-hours required for the various items per cubic yard of concrete was as follows:

Item.	Men-hours per cu. yard.
Tearing down and cleaning timbers....	0.97
Erecting forms	1.74
Mixing and placing concrete...........	1.50
Loading gravel and cement.............	1.06

The substitution of a clamshell bucket when available is expected to cut the cost of loading the car to about 1/3 men-hour, or say 10 cents per cubic yard, and the substitution of a 300-cu. ft. compressor will, it is thought, make it possible to mix and place one batch per minute. The number of batches on the car varies between 112 and 118. The time required at present to unload one car, including time of transporting and of connecting and disconnecting the pipe, is from 3½ to 4 hr.

The concrete mixer and conveyer used for the work was furnished and the portable outfit was designed by the Concrete Mixing & Placing Company, of Chicago.—*Eng. Record* (abstract).

TO KEEP DRILLS RUNNING

Under existing conditions it is found that the actual drilling time for machines on the Rand is less than five hours per day, and as men are paid for an eight hours' day it is apparent that the time wasted in cleaning down and rigging up the machines constitutes a serious loss to the industry. To meet this wastage and at the same time to obtain more holes per machine shift the Modderfontein "B" has, recently, inaugurated a totally new departure, under which expert stope timbermen with blasting certificates are instructed to go underground some hours before the drilling shift, and after making the stopes safe and cleaning down the faces, to rig up the machines ready for an immediate start when the shift comes down. In some cases the stopes will be attended to in a similar manner by the regular night-shift lashing gang where only day drilling shifts are engaged. "With the high wages paid to machine men," says Col. Bottomley, in his last annual report, "I see no reason why even the blasting should not be done by a special gang, thus leaving the drillers to devote a full eight hours to their work. The reduction in working costs under these conditions would be very considerable, and would probably in the end lead to the abolition of contract stoping."—*South African Mining Journal.*

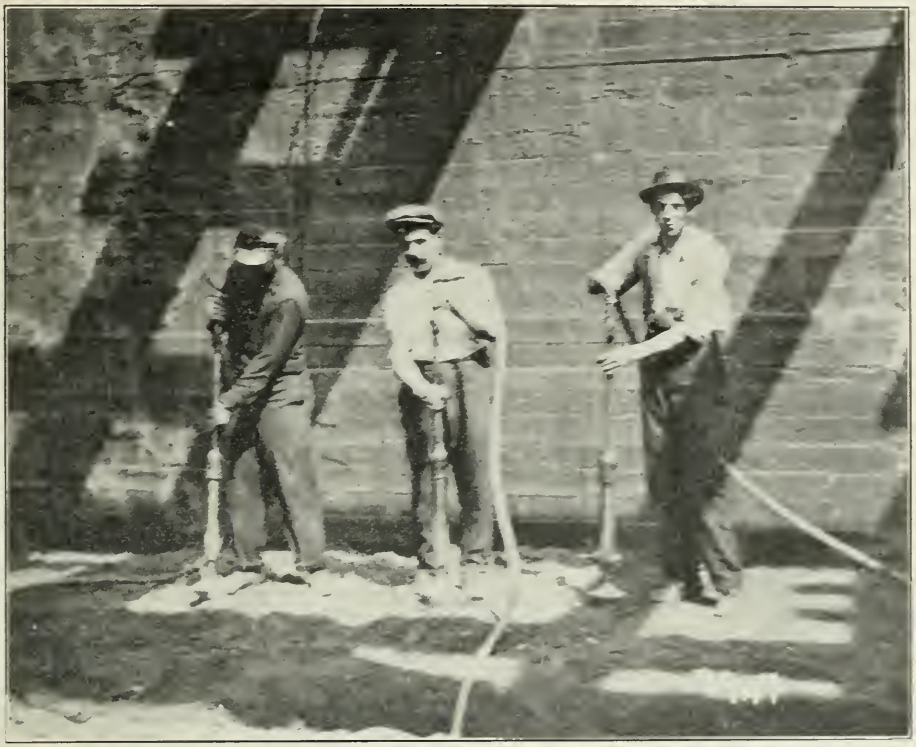


FIG. 1.

PNEUMATIC TAMPERS ON HELL GATE BRIDGE VIADUCT

One of the many notable engineering works which in these later days seems to be always in progress within the limits of Greater New York, and which each involve some special and more or less novel details of design and construction, is the Hell Gate bridge of the New York Connecting R. R. Co. This will be perhaps the most notable and imposing of all the great bridges of the city, and strikingly different from all the others. It will be a heavy, single span, four track railroad bridge at a great height above the water so that navigation will not be interfered with, which requirement must be observed during the entire operation of erecting the structure. The great height of the roadway of the bridge makes the construction of the approaches to it a vast problem in itself, and as these must be used for the conveyance and placing of all the material of the bridge span their early completion is imperative.

From the bridge level down to a height of 70 feet a steel viaduct supported upon equally spaced concrete piers is employed, but for the remaining descent down to 30 feet, about three-quarters of a mile, there are retaining walls with earth filling, an apparently simple arrangement but involving several novel features in the construction. The inner faces of the thin reinforced concrete walls are 57 ft. 6-in. apart. The walls are 3 ft. thick at the top with stepped footings 6 ft. wide at the base. They are connected by tie rods spaced 10 ft. apart, both horizontally and vertically. Stubs for these rods were built into the walls and the connections were made by turnbuckles. Timber trusses extend from wall to wall to carry the four temporary tracks for the working trains. When the filling is brought up to grade the switch tracks and truss caps are removed and the remainder of the truss is left buried in the fill.

The space to be filled is divided into sections by transverse bulkheads and by walls and arches when streets are cut through. There are five trains employed, each comprising 11 dumping cars of about 4 cu. yd. capacity each and an 11 ton dinkey engine, from 250 to 300 cars being handled per day, and the total fill requiring 200,000 cu. yds. The material, which is a mixture of sand, gravel and loam is brought about 3 1-2 miles. The space to be filled is divided into sections by transverse abutments and by walls and arches where streets are cut through, and these sections are filled separately. The filling as dumped from the cars falls in four longitudinal winrows and these are spread into layers about 12 inches thick which are then tamped hard by the use of "Crown" pneumatic sand rammers, such as are used in foundries, in street paving operations and elsewhere.

Air for the tampers is supplied by an Ingersoll Rand compressor, belt driven from a 150 h. p. electric motor, with a free air capacity of 946 cu. ft. per minute. delivered at 100 lb. gage. There is a 3 in. air line 1,400 ft. to the East River and another line of 2,100 feet in the opposite direction, both lines reduced for part of the distance to 2 in. with a 10 part manifold for 1 in. hose in sections where the tampers are at work.

When the tamping is brought up to the tie rods the operation is suspended while the rods are encased in concrete. Wood forms are placed around them and are filled with 1 :6 concrete, which is permitted to set for 24 to 48 hours, according to the weather. Fig. 1 shows three of the tampers in position for work. In Fig 2, they are backed by one of the ribs or buttresses for a street wall.

An additional feature of the work is the rubble chimney construction which rises from weep-holes in the lower part of the viaduct for draining the bays. This chimney construction is shown in Fig. 3.

For the entire operation quite a number of men are employed. The steam shovel gang for loading the trains comprises an engineer, fireman and craneman, and there are six men in the pit gang. There is an engineer and a brakeman on each of the five trains, five laborers and a foreman attend to the dumping and in the bays there are 45 laborers, 2 foremen and 6 tampers. Of the latter sometimes 10 are at work at once, with an equal number of the pneumatic rammers always ready for service. These latter can be oiled and looked after while the others are in use, two machinists being employed for this and to attend to the piping. The concreting of the tie rods is done by 12 laborers and a foreman. The fill has proceeded at the rate of 2 ft. vertical per day.

The work is being done for the New York Connecting Railway, of which G. Lindenthal is Consulting and Chief Engineer, by Holbrook, Cabot & Rollins, New York City. The work is under the direction of. T. B. Bryson for the contractor and Wyllys Russell is Superintendent at the site.

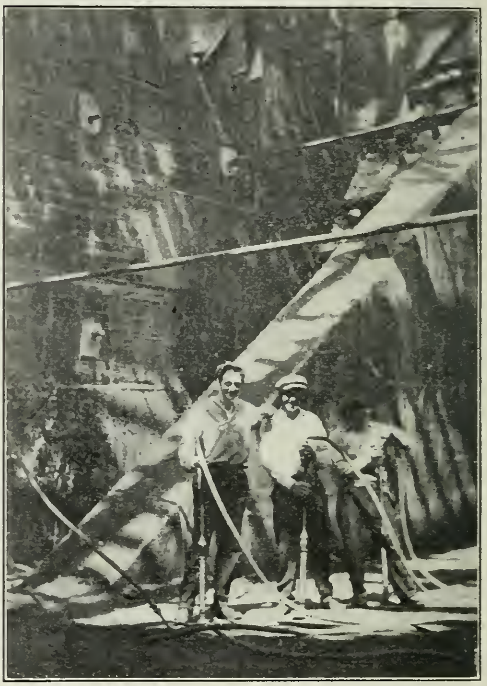


FIG. 2.

FIRST AID FOR GAS ASPHYXIATION OR ELECTRIC SHOCK

In line with its campaign to reduce the number of deaths in the mines of the United States, the Federal Bureau of Mines some time ago appointed a committee of eminent physicians and surgeons to develop an efficient method of resuscitation to be administered by miners or other persons to a fellow-workman overcome by electric shock or by gases in places which cannot be reached by a physician or surgeon in time to save life.

As a result of this committee's report just made, the Bureau of Mines, through Director Joseph A. Holmes, recommends the following procedure in rendering first aid to those in need of artificial respiration.

The recommendations apply not only to men who are overcome by electric shock or gases

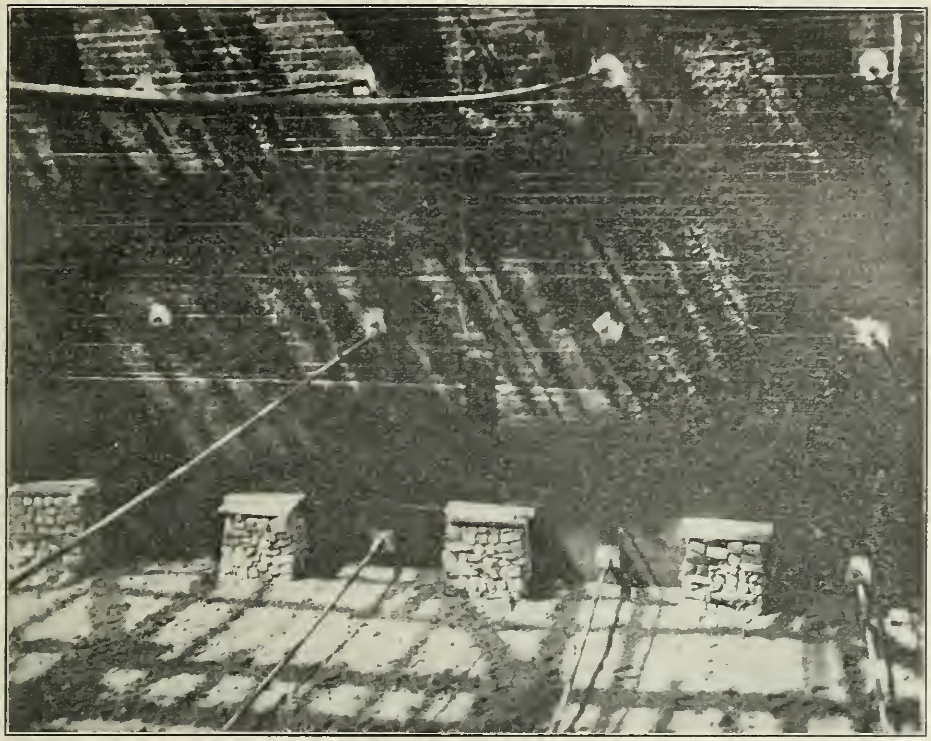


FIG. 3.

in mines, but also to persons suffering from the effects of illuminating-gas poisoning or from electric shock anywhere. The recommendations are, therefore, of importance to many thousands of workmen:

In case of gas poisoning, remove victim at once from the gaseous atmosphere. Carry him quickly to fresh air and immediately give manual artificial respiration. Do not stop to loosen clothing. Every moment of delay is serious.

In case of electric shock, break electric current instantly. Free the patient from the current with a single quick motion, using any dry non-conductor, such as clothing, rope, or board, to move patient or wire. Beware of using any metal or moist material. Meantime have every effort made to shut off current.

Attend instantly to the victim's breathing. If the victim is not breathing, he should be given manual artificial respiration at once. If the patient is breathing slowly and regularly do not give artificial respiration, but let nature restore breathing unaided.

In gas cases, give oxygen. If the patient has been a victim of gas, give him pure oxygen, with manual artificial respiration. The oxygen may be given through a breathing bag from a cylinder having a reducing valve, with connecting tubes and face mask, and with an inspiratory and an expiratory valve, of which the latter communicates directly with the atmosphere.

No mechanical artificial resuscitating device should be used unless one operated by hand that has no suction effect on the lungs. Use the Schaefer or prone pressure method of artificial respiration. Begin at once. A moment's delay is serious. Continue the artificial respiration. If necessary, continue two hours or longer without interruption until natural breathing is restored. If natural breathing stops after being restored, use artificial respiration again.

Do not give the patient any liquid, until he is fully conscious. Give him fresh air, but keep his body warm. Send for the nearest doctor as soon as accident is discovered.

EXPLOSIBILITY OF GRAIN DUST*

As a result of a number of explosions in grain mills and industrial plants in this country and in Europe, and more especially in view of an explosion in a feed grinding plant at Buffalo, N. Y., in June, 1913, by which 33 men lost their lives and upwards of 70 were injured, a co-operative movement between milling interests and the Bureau of Mines was arranged for the purpose of making a scientific study of the explosibility of grain dusts mixed with air, and of methods pertaining to the prevention of such explosives.

The work was started August 1, 1913, and during the preliminary study 13 explosions were investigated which occurred since 1905. These explosions were classified as follows: Cereal mills, 4; elevators, 3; feed mills, 2; starch factories, 2; glucose factory, 1; flour mill, 1. In these explosions 78 were killed, 119 were injured, and the damage to property exceeded $2,000,000.

Since 1911 four explosions have gone upon record in Europe, two in dextrine works, one in a provender mill grinding peas, beans and wheat, and one in a linseed mill, killing 47 and injuring 119.

Samples of the following dusts were collected and the conditions of their production were studied:

Dusts produced in the processes of elevating and handling grain, elevator dusts. Wheat flour dusts from rolls, bolters, purifiers, conveyors, packing machines, etc. Wheat flour dusts from beams, rafters, elevator heads, etc. Dusts produced in the cleaning of oats. Dusts from grinding white corn, yellow corn, oat hulls. Oatmeal dust from packing machines. Floor dusts from elevator sweeping. Oat groat dusts after aspiration.

These dusts were first analyzed in the U. S. Food and Drug Laboratory, Chicago. Experiments were then started in the Bureau of Mines at Pittsburgh to determine the ignition temperature of these dusts, using the method described by R. V. Wheeler in his report on the inflammability and capacity for transmitting explosions of carbonaceous dust liable to be generated on premises, under the Factory and Workshop Acts, 1913.

This method consisted in forcing the dust in a cloud through a glass tube, 3 inches in diameter and 55 inches long, against a heated platinum coil 15.75 inches from one end of the tube. The temperature of the coil was obtained by a Pt-PtRh thermopyle having its hot junction within the quartz tube upon which the coil was wound. Using this method, Wheeler determined the ignition temperature—temperature of propagation—of many dusts, obtaining results varying from 805 deg. C. for sugar, 960-1,035 deg, for starch, 990 deg. for oat husks, 995 deg. for grain (flour-mill) to 1,060 deg. for flour and 1,100 deg. for castor-oil meal. The results obtained upon grain dusts by the authors varied from 995 deg. C. for oat and corn elevator dusts, 1,015 deg. for feed dust from dust collector, 1,020 deg. for ground oat hulls, 1,025 deg. for yellow-corn dust, to 1,115 deg. for wheat elevator dust and 1,235-1,270 deg. for flour dusts. Wheeler worked with samples which had been dried at 107 deg. C., while the authors used the samples as received from the mill.

While the work gave the relative ignition temperatures it did not give the lowest temperature of ignition or the relative inflammability. This latter was determined by means of an apparatus developed in the Bureau of Mines. It consists of an explosion flask of about 1,400 cubic centimeters (85.36 cubic inches) capacity having two tubulures, a platinum coil, a device for driving a dust cloud against the coil and a Crosby pressure gauge for measuring the pressure developed. In each determination 50 milligrams (.00176 oz.) of the dust is forced in a cloud against the coil, which has been previously heated to a known temperature determined by a thermo-couple. The temperature is that inside the coil, and therefore higher than the actual temperature on the outside of the coil. The dust is ignited by the heated coil and a pressure developed within the flask, which is registered by the gauge. The relative inflammability at any temperature is measured by the difference in the pressures developed within the flask.

Determinations were made of pressures developed by the different dusts, as received and dried at 105 deg. C., when they were forced against the coil heated to 1,200 deg., 1,100 deg., 1,000 deg. and 900 deg. C. As no standard has been taken for carbonaceous dusts other than coal dust, Pittsburgh standard coal dust which is very constant in its properties and which is used as a standard in the Bureau of Mines was taken as such and all determinations were run against it and checked against each temperature.

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*Abstract of Preliminary Report by David J. Price and Harold H. Brown, Millers' Committee, Buffalo, N. Y.

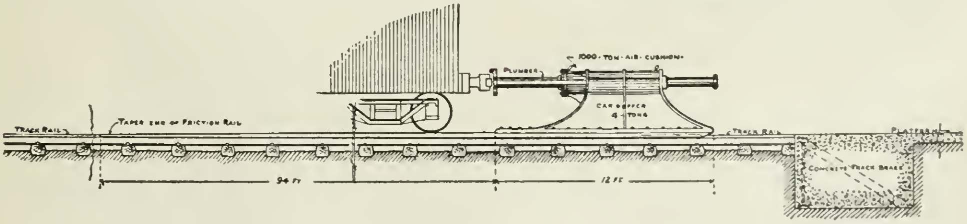
Results indicate that most, if not all, grain dusts are more inflammable than Pittsburgh standard coal dust, higher pressures being developed in most cases and especially so at the lower temperatures. The results also seem to indicate that the dusts from oats and yellow corn are more inflammable than those from wheat or other grain. However, the results are only very preliminary, and it is possible that later work will change this supposition, and probably will change the curves plotted from the results, extending them to still lower temperatures.

It is interesting to note the difference in the inflammability of the dried and undried dusts. In nearly every case the pressure developed was appreciably increased after drying. Three cases are especially noticeable. These gave 0.5 pound pressure or less at 1,200 deg. when undried and over 8.0 pounds when dried, Pittsburgh standard coal dust giving 9.0 pounds at the same temperature. This is an indication of what may be expected when the humidity of the air is decreased.

Experiments carried out by the Bureau of Mines have shown that an explosion could be produced when there was only .032 ounce of coal dust suspended in each cubic foot of air or 1 pound in 500 cubic feet of air. In the experiments of M. J. Taffanel at the Lievin experiment station in France as low a weight as .023 ounce of coal dust per cubic foot of space was in one instance sufficient to produce an ignition.

SLIDING CAR BUFFER

Once in a while, owing either to miscalculation upon the part of the engineer or failure of the air-brakes, a train enters a terminal station with such velocity that it cannot be stopped before reaching the end of the track. To bring the train to a halt when it is not under proper control, buffers of various designs have been used, but it is no simple matter to design a bumper that will stop a train without, on the one hand, doing harm to the train, or, on the other, being seriously damaged itself. Recently a car buffer has been invented which is not rigidly secured to the end of the rails, but is designed to slide upon the rail when the momentum of the train is greater than a certain predetermined amount. This buffer is formed with two long shoes or tapered friction rails that rest upon the track. The train rides up on these shoes, and if not stopped in time strikes a plunger projecting from a pneumatic cylinder. The air cushion back of the plunger serves to retard the motion of the train; but if it is unable to stop it, the whole buffer slides along on the rail, until the section between the buffer and the rail is sufficient to overcome the momentum of the train. In a recent test of this buffer, it was found that a 1,000-ton train traveling at three miles per hour was brought to a stop without sliding the buffer. At four miles per hour, the buffer slid 9 inches. At 8 miles per hour the displacement of the buffer was 3 feet; at 16 miles, 12 feet; and at 32 miles, 40 feet. Of course it is seldom that a buffer is called upon to stop a train traveling more than three or four miles per hour. After the rails have been displaced over 12 feet the rate of friction runs up extremely high and overcomes the momentum with greater relative ease. Because the buffer yields before the impact more or less in proportion to the speed of the train, no damage is done and the train is halted in the shortest distance compatible with safety.—*Scientific American.*



Announcement is made that the Jersey Central is to build a new line under the name of the Eastern & Western, by which certain manufacturing establishments in the neighborhood of Easton, Pa., will be reached. The amount of construction involved is about four miles.

MINE REGULATIONS CONCERNING EXPLOSIVES

The following suggestions were sent to Coal Age by a mine foreman of long experience.

VENTILATION.

1. Have exhaust system of ventilation.
2. Use explosion doors on fan.
3. Current must be neither too strong nor too weak.
4. Use 4- to 6-entry system, work in panels, keep air courses clear of obstruction.
5. Use overcasts instead of doors; if doors, use automatic.
6. Have stoppings substantially built of masonry and kept in good repair, check doors at necessary intervals so that ventilation reaches the face of workings.
7. Use separate splits freely, have all abandoned workings thoroughly ventilated.
8. Have ample ventilation exceed the requirements of the law if necessary.
9. Install duplicate fans and engines so that they can both be used together if necessary.
10. In all narrow work crosscuts should be driven at least every 100 ft., if driven every 200 ft., the limit, and canvas is blown down it will accumulate a dangerous body of gas.

SHOT FIRING.

1. Employ skilled shotfirers acquainted with the extreme danger of gas and dust.
2. Use permissible explosives, copper bar and needle and clay tamping, fire one hole at a time with a battery when all men are out of the mine, commencing to fire shots, advancing against the air.
3. Do not shoot off the solid or holes drilled beyond the undercutting, shoot center hole first. If coal is 5½ ft. high and place 10 ft. wide shear one side or shoot in two layers.
4. Do not overcharge shots or use mixed explosives.
5. Holes must not exceed two inches in diameter.
6. Carefully inspect places for gas before shooting and after for fire, bad roof and gas.
7. Wet sides, roof and bottom for 80 ft. back before shooting.

DUST.

1. Use sprays to wet the coal in the cars and spray empty cars outside or at the shaft bottom.
2. Keep rooms and haulage ways clear of dust by loading it out, keep coal below beds of cars.
3. Use water or exhaust steam for moistening dust.
4. Before shooting, wet sides, roof and bottom for distance of 80 ft.
5. Use tight wood or steel cars to prevent leakage of coal and clean it up regularly before it is ground into powder.
6. Dust is dangerous, because when acted upon by a flame, it generates carbon monoxide, it absorbs oxygen out of the air.

GAS.

1. Do not allow mixed lights in a mine generating explosive gas.
2. Examine all places regularly and thoroughly for gas.
3. Do not allow accumulation of gas in worked-out portions of mine.
4. Consult the barometer for changes in the weather.
5. Employ competent and trustworthy firebosses and assistants.
6. Drawing stumps and pillars, take the coal out clean so roof can cave.

MISCELLANEOUS.

1. Have good discipline in the mine.
2. Systematic timbering of working places to suit conditions.
3. Mine foremen, assistant mine foremen and fire-bosses must all be sober, competent and respected men and see that they observe fully the requirements of the mining law.
4. Have danger signals printed in all languages spoken at the mine.
5. Have accurate surveys made of the worked-out or abandoned sections of mine.
6. Instruct all classes in the danger of mining.
7. At least instruct all company men in First Aid and use of helmets.
8. Prohibit electricity in a gaseous mine and carefully guard its use in a nongaseous mine.
9. Use stone dust to deaden coal dust explosibility.
10. Work all rooms on retreating system.
11. Prohibit the breaking of large pieces of rock by dynamite on top of them, do not allow shots to be fired in air courses, headings and traveling ways unless wires are properly guarded, men warned and dust wetted.
12. In gaseous mines work rooms from one side only.
13. Shear and undercut coal properly before shooting.

COMPRESSED AIR
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EVERYTHING PNEUMATIC
Established 1896

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OUR NINETEENTH VOLUME

Our present issue completes the nineteenth year of publication of COMPRESSED AIR MAGAZINE, and the table of contents for the assembled volume will be ready to go out with the January number.

In looking over the volume as a whole and comparing its contents and make-up with those of the earlier years the advanced scope and status and the extended reach and employment of compressed air are strikingly apparent. Compressed air asserts itself in all the industries and no great undertakings are carried to successful completion without its aid. So many workers are now in touch with compressed air, so many think compressed air when they have anything to do, and they contrive so many new ways of using it and so many varieties of novel apparatus that it is no longer possible, even if it were necessary or desirable to speak of these in detail. And so, curiously enough, it is on account of the multitude of novelties that they do not appear so continuously on our pages as in the earlier volumes. Things are so numerous, and their individual novelty is so subdivided, and besides this, so many now know so much about these things that what once would have been welcomed as news is now already sufficiently well known without formal publicity.

As suggestive of the growth and extension of pneumatic interests it may be noted that our monthly lists of patents issued contain double the numbers recorded on our pages a dozen years ago, and, besides that, in our later selections we omit certain classes of patents, such, for instance, as those relating to pneumatic tires, wind power, aviation, etc.; yet still the variety of inventions reported as possessing some pneumatic feature or interest is continually astonishing, and it would be impossible generally to report and describe them more in detail.

With the limited space at our disposal it has seemed better to deal with pneumatic concerns in a large way and to present such matter as will appeal to the greater number of our readers. It frequently happens that the make-up of one of our issues has one preponderating topic, and by this fortuitous grouping of articles more or less related concentrates the interest. For instance the present might be called a tunnel number, and certainly it deals with perhaps the most important of compressed air activities.

The first article might be challenged as not a compressed air article at all, as only pick and shovel seem to have been the tools of the German soldiers, but the tunnel certainly was indebted to compressed air for its building in the first place, and the relation could not be forgotten. The story of the Sheep's Creek Tunnel, which, let us not forget, is in Alaska, is up to date in every particular, and is to be regarded with satisfaction by all concerned.

The scheme for building East River or other tunnels by the use of movable caissons above them, instead of by shields within, may be said to be perhaps rather more than up to date, but it is not difficult for us to believe that it heralds another compressed air triumph in the not distant future.

Another scheme promising certain ultimate fulfillment is that for the labyrinth of tunnels to be built for freight distribution in New York. The story of their construction may be expected to figure as a "to be continued" intermittant serial in future volumes of Compressed Air Magazine.

In our present issue also attention is called to the Baltimore tunnel which paid for its construction, as we might say, on the spot. Tunnels have quite a habit of paying for themselves, directly or indirectly, and the building of them may be expected to go on continually at a not diminishing rate. Most of them will have some special features of design, or will develop incidents of interest in their construction which it will come in our way to tell about, and the vast field of other compressed air employments besides tunneling will be attended to as they come along.

JOINT CONFERENCE ON AVIATION

The Aëronautical Society of America, in collaboration with many national engineering organizations in this country, will on February 5 and 6, 1915, consider the inventions tending to increase the stability and safety of flight in heavier-than-air machines.

All inventors wishing to submit their inventions are invited to communicate with the Technical Board of the Society, 29 West 39th street, New York City, and submit to it all the data in their possession, such as patents, descriptions, data of tests, etc. If the inventor is in a position to submit a model or can show an apparatus of working size, he should so state to the Technical Board. It must be clearly understood that all information so submitted may be presented in public meeting of the Society, and, therefore, no inventions or data of a secret nature should be communicated to the Technical Board.

In addition to the Technical Board and the representatives of the Aëronautical Society of America, representatives of several national engineering organizations will take part. The following have already sent in lists of their representatives: The American Society of Mechanical Engineers, The American Mathematical Society, The American Physical Society and The Massachusetts Institute of Technology.

FANS FIGHT FIRE

In Boston not long ago, a fire broke out in the basement of a building occupied by a wholesale paint and chemical concern. The fumes and smoke became so thick it was impossible for the firemen to enter the basement or direct a stream with any effectiveness, when someone thought of electric fans. A half dozen of the ordinary 16-inch size were quickly requisitioned by the fire chief and their breeze was directed down the stairway. As soon as the rear basement windows were broken to allow the escape of the smoke and fumes, the effect of the fans gradually cleared the basement so that the firemen could work quickly and effectively in extinguishing the flames.

POWER RECOVERED

At a mine in South Africa the water supply has to be drawn from a considerable distance, and must, on its way, cross a ridge some 600-feet high. The water arriving at the mine is thus under considerable head, and power is recovered from it by means of Pelton wheels driving dynamos. In this way from 90 to 160 horse-power is gained, according to the volume of water flowing, and is utilized for various purposes at the mine. At another mine the cars conveying the ore run down an incline a vertical distance of about 250 feet. From the 2,200 tons of ore daily mined some 50 horsepower of electrical energy is here recovered by winding the cable of each car around a drum which actuates a dynamo.

TAYLORISM AND THE BONUS SYSTEM

BY FRANK RICHARDS

I am glad to note that the industrial journals, which have done so much for the promotion of the efficiency of machine tools and of manipulative processes, are now disposed to turn their attention to the worker himself, upon whom the ultimate success of all methods must depend. Just now the American industrial fad—and it is practically confined to America and must have its run here as other American fads do—is scientific management. The beginning of the so-called scientific management, which is still much more written about than practiced, is Taylorism, which has been spoken of in *The Engineer,* London, as "a peculiarly hideous method of dehumanization," a characterization which I think fits it well. Far from having the ultimate effect of promoting industrial conditions in the interest of either employer or employe, it deliberately brings about the degradation and belittlement of the individual American workman, it is inimical to the development of skill and paralyzes all incentive.

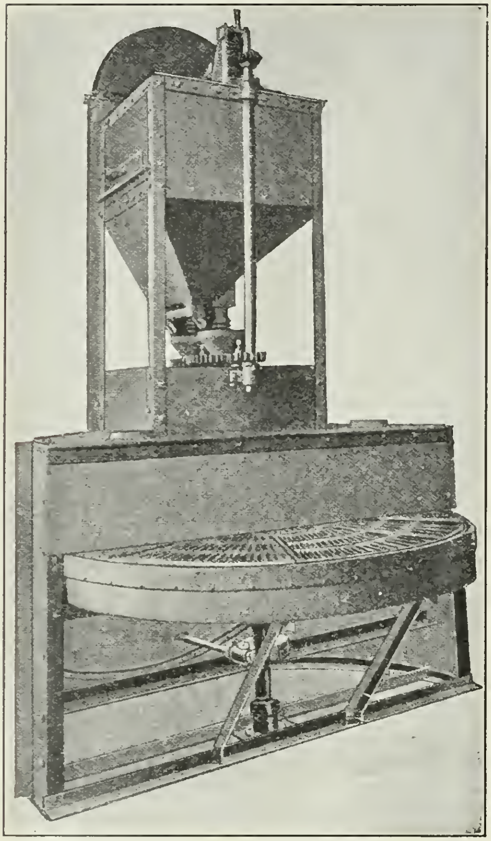
It is fortunate, or otherwise, for the system that it has had many and zealous advocates whom Mr. Taylor has hypnotized—I use the word deliberately—who have written voluminously concerning the workings of the system, and have spread their own stories as to what has been accomplished under it, while few or none have had the time or the interest to put forth their views and experiences in opposition, so that Taylorism and so-called scientific management stand before the public almost entirely upon *ex parte* testimony, and it would seem that any honest statements of opposing views should not be too hastily squelched.

Speaking now a little more precisely: Under the Taylor system the doing of all work is to be planned in detail for the workman, and every move he is to make in doing a certain job is prescribed for him, with or without the time in seconds for each motion. This schedule is to be followed absolutely. Mr. Taylor has said before the American Society of Mechanical Engineers that the workman should be required to do his work so exactly as prescribed, that if at any time he saw a quicker or a better way of doing the work, that way must be ignored. I do not know that Mr. Taylor has ever said that the less a man knows about his work the better, but the man who knows nothing at all would seem to be his ideal workman. What incentive could there be under the Taylor system for any man to do with his might what his hand found to do?

THE BONUS SYSTEM.

Another fundamental feature of scientific management which is much bragged about is the "bonus system of rewarding labor." A self-respecting workman never wants to be rewarded, but just honestly paid for his work. The bonus system dodges the honesty. It is a singular fact that, so far as I know, only machinists and workers in trades allied to them, have been regarded as such simpletons as to make it safe to propose the bonus system to them. Of course, no one has ever had the hardihood to propose the bonus system of rewarding labor to the collar girls of Troy, to the glove workers of Gloversville, to the hat makers at Danbury, at the knitting mills of Cohoes, the textile mills of Lowell, Lawrence and Fall River, nor among the garment workers of New York. In such places as these the worker is paid for just what he does, and according to the amount of work accomplished. If he is paid a certain sum of money for a specified quantity of work he is paid 50 per cent. more money for 50 per cent. more work, and so on according to the work done.

Under the bonus system a certain rate of pay is fixed for a certain amount of work done in a given time, say a day; then if the man does more than the stipulated amount in the given time, entirely through his own exertions and with the employer getting the benefit of the increased productivity of his plant, he is not paid at the same rate for the additional amount of work done, but is given a "bonus" amounting usually to one-half—sometimes less and seldom more—of the additional amount fairly earned. To put it in plain figures: if a man is paid $3 for producing 100 pieces of a certain product in a given time, he should be paid $4.50 if he produces 150 pieces in the same time; and he would be paid at that rate under the system ruling in the factory towns above mentioned. Under the "bonus system for rewarding labor" he would be paid $3.75 or less. It is astonishing that such a system should have had even temporary acceptance anywhere. If I misrepresent the system in any way I would be glad to be corrected. If the system is essentially honest I would like to have it proved to me.—*Machinery.*



AUTOMATIC SAND BLAST MACHINE

The half-tone above shows an automatic machine specially designed for handling small castings designed by the W. W. Sly Manufacturing Company, Cleveland. It consists of a slowly rotating table half of which is constantly enclosed in a chamber where moving sand blast nozzles play on the work to be cleaned. In the smaller sizes of this machine two nozzles are used and in the larger sizes there are four, and these move about so that all the castings get their share of the abrasion.

The machine works on the gravity system, and is connected to a Sly dust arrester which removes flying particles of sand and dirt. A split rubber curtain across the front of the machine protects the operator from the dust and at the same time allows the castings to pass by easily. The table is built with heavy cast iron arms held in place by a forged steel ring. The grates composing the top of the table are made in sections so that they may be easily removed. The sand hopper is cast iron and the movement of the hoppers is taken from the main drive. The used sand falling through the table into a steel hopper drops from there into the boat of a bucket elevator which returns it to the feed hopper.

HARDNESS OF STONE

There have been constant calls for some test that would show the hardness of stone and the ease of working. It is popularly supposed that hardness, ease of working and strength are synonymous, or at least very intimately connected. This is not so, except in a very general way, with regard to stone. The stone that shows by far the highest crushing strength of any ever tested in this country, a Southern granite, is not particularly hard, and is easy to work. On the other hand, there are stones of low crushing strength that are very hard and refractory. As yet no satisfactory method of testing the hardness of stone and the ease of working has been adopted, although several methods have been suggested. Every authority agrees upon the desirability of such a test.

There is now in existence a scale of hardness as applied to the non-metallic minerals that has been in use for some years, is recognized as standard, and has proved of great value. This is known as Moh's Scale, and is graduated as follows:

1. Talc.
2. Gypsum or rock salt.
3. Calcite.
4. Fluorite.
5. Apatite.
6. Orthoclase.
7. Quartz.
8. Topaz.
9. Sapphire or corundum.
10. Diamond.

Any member of the series will scratch any of the others below it. Talc is readily scratched by the finger-nail, and gypsum with difficulty. By this scale it will be seen that the hardness of granite, for instance, is between 6 and 7. But it is apparent that any such scale as this will not serve to register the comparative hardness of the different varieties of granite, or of any other stone.

THE MINER

He must work in gas and see in the dark,
The music he hears is the air-drill's bark,
It isn't no picnic in the park,
    It isn't no cinch he's stole!
He's carpenter, plumber, machinist, yes,
A sort of surveyor, too, I guess,
A little of everything more or less,
    The miner who digs the hole!

—*Berton Braley.*

NEW COMMERCIAL OXYGEN PLANT

The Linde Air Products Company, Forty-second Street Building, New York City, is to erect its twelfth commercial oxygen plant in Philadelphia. The building will be one story high, fireproof throughout, of brick, steel and concrete. Its equipment will comprise the special Linde rectifying apparatus, air compressors, oxygen pumps, etc., all electrically, individually operated. The Linde company, in the sure anticipation of large increases in the sale and use of oxygen, is allowing ample space for doubling the capacity of the plant which, to begin with, will be capable of putting out 2,000,000 cubic feet of oxygen per month. In the past two years the company has built nine plants, and others are in contemplation. In furnishing oxygen with as little expense for transportation as possible, and at prices which make it readily available, it is doing valuable service in the promotion of the use of oxygen processes.

NOTES

All hoists, save the Sacramento, at the Copper Queen mines, Arizona, are operated by compressed air, generated at the central power-plant, by machines having a total capacity of 21,000 cu. ft. of free air per minute.

The nominating committee of the American Institute of Mining Engineers has made the following nominations for officers of the Institute to be voted for at the annual meeting in 1915: For president, William L. Saunders, district O. For vice-presidents, Sidney J. Jennings, district O; and Philip N. Moore, district 3. For directors, Samuel A. Taylor, district 2, Robert W. Hunt, district 3; Hennen Jennings, district 9; George C. Stone, district O; and W. H. Aldridge, district 6. William J. Cox is chairman of the committee.

The Yale "Bowl" has 30 tunnels for the entrance of spectators to the ring of seats. They are each 7 ft. wide and 8 ft. high inside and about 140 ft. in length. There is also one tunnel to the arena 15 by 10 ft. and a players' tunnel 10 by 8 ft.

The Lidgerwood Manufacturing Company, New York, probably hold the record for hoisting machinery. In their forty odd years of business they have built more than 37,000 steam, compressed air and electric hoists. Some of them still running have been in use more than thirty years although great improvements are shown in the later machines.

Inventors are to have a show all their own at the Grand Central Palace during the week beginning December 12. It will be known as the International Exposition of Inventions, and the inventors exhibiting the children of their brains will attempt to get into touch with men of capital who will adopt them.

The New Zealand Sulphur Co. has spent about $100,000 in preparations for mining sulphur on White island, a volcanic area in the Bay of Plenty of the North Island, but during September it was found that the camp had been demolished and 10 men killed by the collapse of a high cliff; probably by some volcanic disturbance.

The largest pneumatic caisson job in Canada has recently been completed for the Montreal Customs Warehouse by the Foundation Company. One hundred and thirty-two piers were sunk, and an unusual feature of the job occurred in placing the concrete, which work was carried on while the temperature was 30 degrees below zero.

According to the official statement of the British War Office, their aviators are covering an average of 2,000 miles a day. Up to September 21st they had flown 87,000 miles and remained 1,400 hours in the air. By now these figures have been trebled. A certain French corps commander's opinion is that a single aeroplane is as valuable as an entire division of cavalry.

Perhaps one of the most interesting, as well as one of the least known phases of the oil industry in California, is mining for oil in Sulphur mountain and elsewhere in Ventura county and in the Coalinga field by tunnels driven into oil-bearing strata. The oldest of these tunnels, which was dug in 1861 and produced at first about 60 barrels of high gravity oil a day, is still yielding small quantities of oil and considerable water.

The Institution of Engineers of the River Plate, with offices at 195 Cinco de Mayo, Buenos Aires, Argentina, will be glad to file any catalogs or circulars on engineering subjects which manufacturers may send. The Institution library has facilities for storing and classifying these documents, and they will be consulted by members.

The first New York subway was opened to the public ten years ago. To the close of the last fiscal year, June 30, 1914, the subway has carried 2,332,401,305 passengers, an average of more than 233,000,000 passengers per annum, the present week-day number being approximately one million. The total operating revenue for the same period was $120,084,198. and the operating expenses and taxes $49,549,845. The rental paid to the City amounted to $20,421,069.

Among the exhibits of the firm of Piccard, Piccet & Co., Geneva, Switzerland, at the Swiss National Exposition being held at Berne, Switzerland, is an impulse wheel built for the Fully high head plant of the Société d'Electrochimie, a French company. This is a horizontal shaft wheel which will develop 3000 hp. at 500 r.p.m. Its wheel diameter is 11½ ft. and the jet diameter is 1½ in. The Fully plant will have the highest head water power in the world by a considerable margin.

In an investigation of the use of electricity in coal mines, reported to the British Association by Dr. W. M. Thornton, it was found that electric bells often produce sparks at trembler or push button, and that these have sufficient intensity to fire mine gases or coal dust. He would enclose all electric lamps, fuses, etc., even the smallest. Not all sparks are dangerous, however, and gas could not be ignited with the blue brush discharges from a high-speed belt.

With the submarines and the air craft sharing the glories of the world's butcher carnival it would have been strange if subterranean devices also had not been heard from. We are told that at one point where the opposing trenches are very close to each other, and where the French were "much annoyed" by the fire of a German machine gun which was otherwise inaccessible, some men who had been recruited from the coal mines drove a tunnel to the spot and blew up the nuisance.

The application of varnish by means of an air spray has heretofore been attended with considerable difficulty on account of the tendency of the varnish to stiffen and turn white when it struck the surface being coated. This has apparently been overcome by the simple expedient of putting an electric heater in the pipe that furnishes the compressed air for forming the spray. With the air heated in this way the varnish flows freely through the orifices of the air brush, and dries quickly and smoothly.

A new process for popping corn has been introduced by a recently patented machine which causes the kernels to explode by producing a pressure within them through the application of heat while they are maintained under less than normal atmospheric pressure. By creating a partial vacuum in the popper, the moisture in the kernels is changed into steam at a lower temperature than could be accomplished under ordinary pressure. In this manner a larger quantity of water is converted into steam at the moment of popping, while, the atmospheric pressure being below normal, the resulting explosion fluffs the corn greatly.

The deplorable disaster at the mine of the Franklin Coal & Coke Co., near Royalton, Ill., in which at least 50 lives were lost, is claimed to have been due to an explosion that resulted when a miner's lamp came in contact with a pocket of gas that had been noted the night before by a mine examiner and marked dangerous. The precautionary action of reversing the ventilating fan to suck out black damp after the fatal explosion is claimed by state mine examiners to have saved 285 men who were scattered through the underground passages and finally made their way to the open air.

La Paz, Mexico, is the chief pearl-fishing center of the Pacific coast of America, ranking third on the globe, with $2,000,000 as the value of the annual export. The mollusks found there are never seen in beds, like the edible oyster, but must be sought singly by divers. The shells are often fifteen inches across, and these produce mother-of-pearl. As an occupation, pearl fishing is slow suicide, but nearly all the 6,600 inhabitants of La Paz are engaged in it. Deafness is followed by nervous prostration, and it is rarely that a diver can hold out more than five years at this strenuous occupation.

The United States Bureau of Mines has begun the collection of a general library of petroleum literature, under the direction of W. A. Williams, chief petroleum technologist. The details of this work have been assigned to Dr. David T. Day, who has recently been transferred from the United States Geological Survey as petroleum technologist, and who will also assist in a thoroughly organized research into the chemistry of oils, which is being developed by the Bureau of Mines. The importance of such a library is so manifest that it is hoped all technologists will aid in the work by exchanging with the bureau all available books and maps on this subject.

Extremely high temperatures are being obtained by combining a jet of air or oxygen or an oxyacetylene or oxyhydrogen flame with an ordinary electric arc. The simplest form of the apparatus used for this purpose has a hollow carbon electrode through which a blast of air or oxygen is blown inside the electric arc. The metal to be heated forms the positive pole and the carbon electrode the negative pole. It is said that the gases burning within the arc produce a temperature greatly in excess of that produced by the electric arc alone. Other forms of apparatus are used in which an oxyacetylene or oxyhydrogen flame is projected upon the electric arc.

In the course of his last annual report, the Boksburg (South Africa) Inspector of Mines says that towards the latter end of the year two light hammer water rock-drilling machines, viz., the Leyner and the Atlas drills, were introduced into some of the mines. From figures kindly given by the managers using the drills the results are extremely satisfactory. The drills have many advantages over the piston drills in that they weigh only about one-third, require fewer persons to run them and above all it is impossible to work without water, which is fed to the face of the bit through hollow steel. All the drills are star bit and the holes consequently start at a smaller diameter and finish up only slightly less.

At the Turkey Creek pumping station, Kansas City, Mo., ash handling by vacuum conveyor cost $6.40 per day less than by the former system of hand removal. The plant, installed by the Green Engineering Company, 50 Church St., N. Y., removes ashes from the ash pits in the basement to a tank from which they feed by gravity into railway cars. The railroad pays $6 per car for the ashes. The guaranteed capacity of 250 lb. per minute was exceeded in test by 20 lb. Two men remove all ashes, load cars, clean the machine and take general care of the boiler-room basement. Costs of operation during 178 days were $712 for labor and $37.19 for repairs. Against this are receipts for $186 for 31 cars sold, a figure balanced by the estimated cost of power for running the machinery three and one-half hours per day. By the old method five men and a mule would have cost $1,886.80.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 6.

1,112,481. AUTOMATIC BRAKE MECHANISM FOR TRAINS. John Samuels, Rock Slope, Ala.

1,112,493. QUICK-ACTION TRIPLE-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

1,112,494. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE. Walter V. Turner, Edgewood, Pa.

1,112,495. DUPLEX-PRESSURE ELECTRIC PUMP-GOVERNOR. Walter V. Turner, Edgewood, Pa.

2. The combination with a pump governor normally operated according to the degree of pump pressure for cutting the pump into and out of action, of a valve device for supplying fluid to the pump governor at a pressure less than the pump pressure, to thereby cause the governor to cut the pump into and out of action at pump pressures in excess of the pressures for which the governor is adjusted.

1,112,496. ART OF MAKING CASTINGS. William C. Urban, Granite City, Ill.

In the art of making castings, the process which consists in confining molten material in a primary and a secondary compartment, the latter being provided with an admission port through which molten material may flow from the primary compartment and with a discharge port through which the molten material is discharged; closing said discharge port to prevent the escape of molten material from the secondary compartment, opening and closing the admission port while the discharge port is closed, introducing fluid under pressure into the secondary compartment, and opening and closing the discharge port while the admission port is closed.

1,112,563. PNEUMATIC PISTOL. DANIEL R. SACKMAN, Cleveland, Ohio.

1,112,636. AUTOMATICALLY CLOSING AND OPENING RECEPTACLES. THOMAS W. MCNEILL, Chicago, Ill.

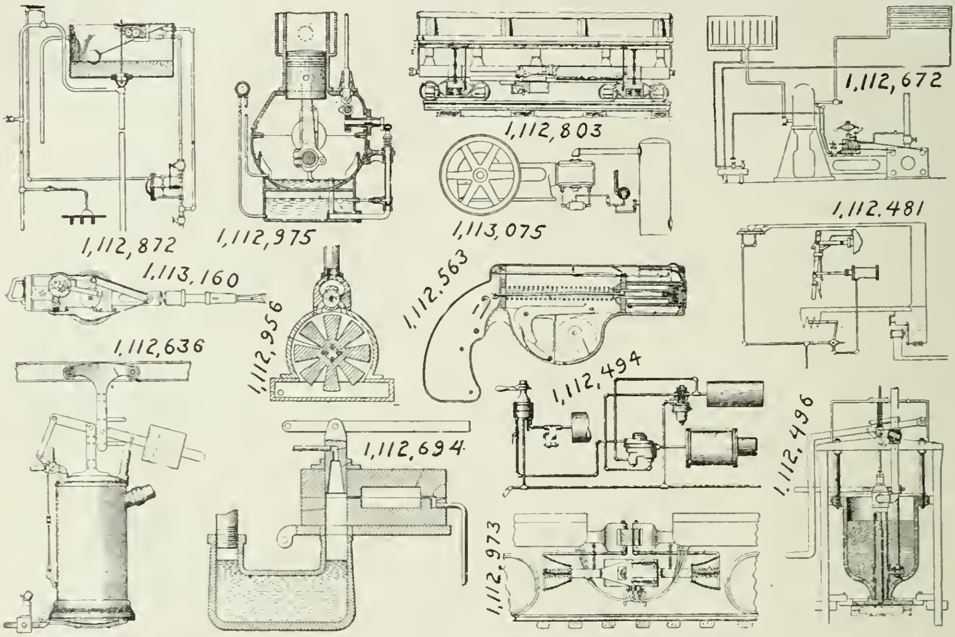
1,112,672. SAFETY APPLIANCE FOR AMMONIA-COMPRESSORS. ALBERT L. BROWN, Little Rock, Ark.

1,113,077. AIR-GUN. BYRON WILLETT, Plymouth, Mich.

1,113,155. FLUID-MOTOR. WILLIAM P. ESPY, Springfield, Ohio.

1,113,160. MINING-MACHINE. GEORGE E. LYNCH, Columbus, Ohio.

1. The combination of a frame, a reciprocating tool mounted on the frame, a piston connected to the tool, an air compression cylinder in which said piston works, a toggle lever system connected to and adapted to retract the tool and piston, an electric motor mounted on the said frame, and power transmitting devices between the motor and toggle lever system adapted to convert the continuous rotation of the motor into a reversing or oscillatory movement of the toggle levers, said transmission devices comprising parts having a lost motion connection.



PNEUMATIC PATENTS OCTOBER 6.

1,112,694. ART OF MAKING CASTINGS. CHARLES M. GREY, East Orange, N. J.

1. In the art of making die castings, the improvement which consists in introducing metal from a reservoir into the die and utilizing the flow of metal to compress the air or gases and to force the same into a chamber separate from the die.

1,112,803. CUSHIONING DEVICE FOR AIR-CYLINDERS OF DUMPING-CARS AND BRAKES. WILLIAM D. JONES, Patillas, Porto Rico.

1,112,872. VACUUM SYSTEM. JULIAN N. WALTON, Brooklyn, N. Y.

1,112,956. TWIN VACUUM-TURBINE. PETER F. WHITE and MERCER M. LEONARD, Leavenworth, Kans.

1,112,973. AUTOMATIC AIR-BRAKE HOSE-COUPLING FOR CARS. EDWARD J. BRICKER, Minneapolis, Minn.

1,112,975. OIL-DISTRIBUTING MECHANISM. ALANSON P. BRUSH, Flint, Mich.

1,113,075. CONTROLLING DEVICE FOR FLUID-COMPRESSORS. CHARLES WAINWRIGHT, Erie, Pa.

OCTOBER 13.

1,113,257. METHOD AND MEANS FOR AUTOMATICALLY APPLYING DIFFERENTIAL AIR-PRESSURE TO COMPARTMENTS OF SHIPS. FRANK JULIAN SPRAGUE and FRANK DESMOND SPRAGUE, New York, N. Y.

1. The combination with the fluid tight compartments of a vessel, of means for supplying compressed air to the several compartments, and reversibly operative means capable of effecting automatic differentiation of the air pressures therein in accordance with their respective distances from an injured compartment.

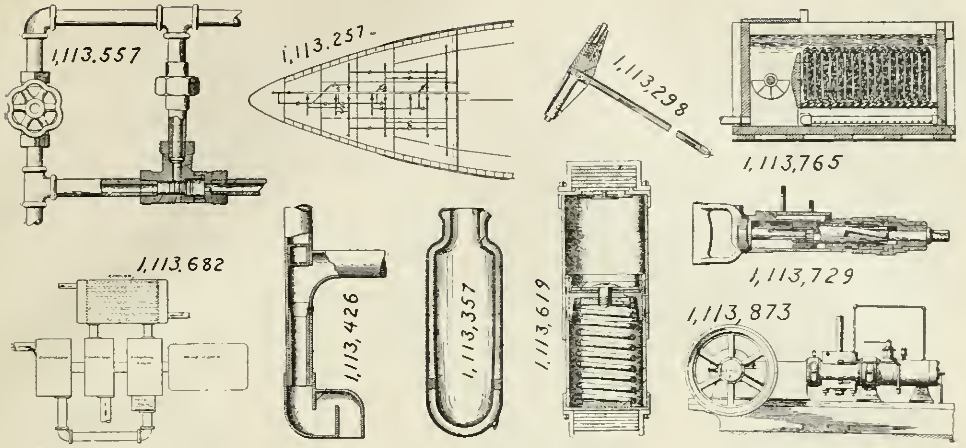
1,113,298. PNEUMATIC AGITATOR FOR ICE-MAKING APPARATUS. FRANK L. BERRY, Spokane, Wash.

1,113,314. AIR - BRAKE - CONTROLLING MECHANISM FOR BLOCK-SIGNAL SYSTEMS. DAVID DALE, Chicago, Ill.

1,113,357. VACUUM-BOTTLE. JOSEPH F. LAMB, New Britain, Conn.

1,113,370. PNEUMATIC SPRING FOR VEHICLES OR SHOCK-ABSORBERS. WILHELM L. OSTENDORF, Wilkinsburg, Pa.

1,113,426. SUCTION APPARATUS. ROBERT GALLOWAY, Buffalo, N. Y.



PNEUMATIC PATENTS OCTOBER 13.

1,113,557. SANDING DEVICE. ALBERT EDMUND HUDSON, Calgary, Alberta, Canada.

1,113,619. SHOCK-ABSORBER. CHARLES H. HAMMERSMITH, Brookfield, Ill.

1,113,682. GAS DESICCATION. JOHANN F. M. PATITZ, Milwaukee, Wis.

1,113,729. PERCUSSIVE TOOL. JOHN U. ADOLPH, Easton, Pa.

1,113,765. DYEING PROCESS. JAMES J. FEARON, Philadelphia, Pa.

1. As an improvement in dyeing skein yarn with sulfur dyes, the mode herein described, which consists in first subjecting the yarn to the action of a liquid dye bath, and then aerating a liquid bath in which the yarn is contained by passing air through said bath.

1,113,873. MEANS FOR COOLING THE VALVE-CHESTS OF AIR-COMPRESSORS. CLEMENT W. BORING, Bradford, Pa.

1,113,902. PROCESS OF TREATING TOBACCO. LEO W. LAWRENCE and FREDERIC F. BAHNSON, Winston-Salem, N. C.

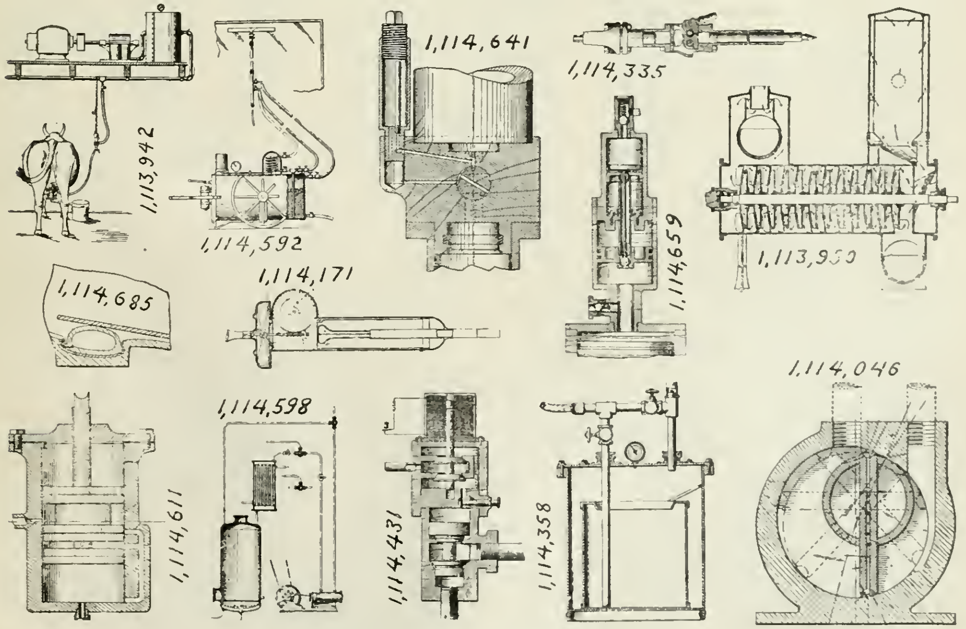
4. The process of artificially aging tobacco, which consists in subjecting it to the action of a maintained highly humid atmosphere, then subjecting it to the action of an atmosphere of maintained relatively low humidity, and then repeating these steps in order until the tobacco is properly aged.

OCTOBER 20.

1,113,942. MILKING-MACHINE. OSCAR ANDERSON, Newark, N. J.

1,113,950. AIR-CONDITIONING APPARATUS. ALLEN A. BLOMFELDT, Chicago, Ill.

1,114,046. VACUUM-PUMP. AMANDUS C. ROESSLER, Mineola, N. Y.



PNEUMATIC PATENTS OCTOBER 20.

1,114,059-60. SUCTION CLEANER AND DUST-SEPARATOR. Ira H. Spencer, Hartford, Conn.

1,114,075. PERCUSSIVE HAMMER, DRILL, AND THE LIKE. William Henry Wakfer, South Norwood, England.

1,114,126. MEANS FOR DISTRIBUTING OXYGEN. Alexander Bernhard Drager, Lubeck, Germany.

1,114,152. AIR-BRAKE APPARATUS. Frank Kosier and Thomas R. Kosier, Ludlow, Ky., and Thomas Bemis, Indianapolis, Ind.

1,114,155. APPARATUS FOR RAISING SUBMARINES AND SUBMERSIBLES. Lucien Auguste Josue Leduc, Tours, France.

1,114,171. PNEUMATIC CLEANER. Hubert Meredith-Jones, New York, N. Y.

1,114,285. PNEUMATIC SPRING FOR VEHICLES. William K. Omick, Detroit, Mich.

1,114,335. PRESSURE-FLUID TOOL. Lewis C. Bayles, Johannesburg, Transvaal, and Albert H. Taylor, Easton, Pa.

1,114,358. COMPRESSION-TANK. Joseph L. Hooker, Anderson, Ind.

1,114,421. PNEUMATIC PIANO-PLAYER. Frederick W. Winter, San Francisco, Cal.

1,114,431. PNEUMATICALLY-TIMED AIR-VALVE. Clinton L. Bopp, Hawkeye, Iowa.

1,114,592. HYDROPNEUMATIC WINDOW-CLEANING APPARATUS. Clinton C. DeWitt, Shrewsbury Park, Mo.

1,114,598. PROCESS FOR THE EXTRACTION OF FAT FROM BONES, MATERIALS SUITABLE FOR GLUE MANUFACTURE, AND LIKE SUBSTANCES. Ernst Fischer, Charlottenburg, Germany.

1,114,641. APPARATUS FOR LUBRICATING PNEUMATIC DRILLS. Vincent J. O'Brien and George A. Oliver, Denver, Colo.

1,114,642-3. APPARATUS FOR ELECTRICALLY CONTROLLING AIR-BRAKES. Edward L. Orcutt, Somerville, Mass.

1,114,644. SPEED-REGULATING MECHANISM. Edward L. Orcutt, Somerville, Mass.

1,114,659. FLUID-PRESSURE-DRIVEN PUMP. Carley Gould Weld, North Chatham, Mass.

1,114,671. BELL-RINGER. Charles A. Bates, Marshalltown, Iowa.

1,114,685. PNEUMATIC HEEL FOR BOOTS AND SHOES. George Terry Trist Freeman, Southsea, England.

OCTOBER 27.

1,114,741. TRIPLE-VALVE DEVICE. Fred B. Farmer, St. Paul, Minn.

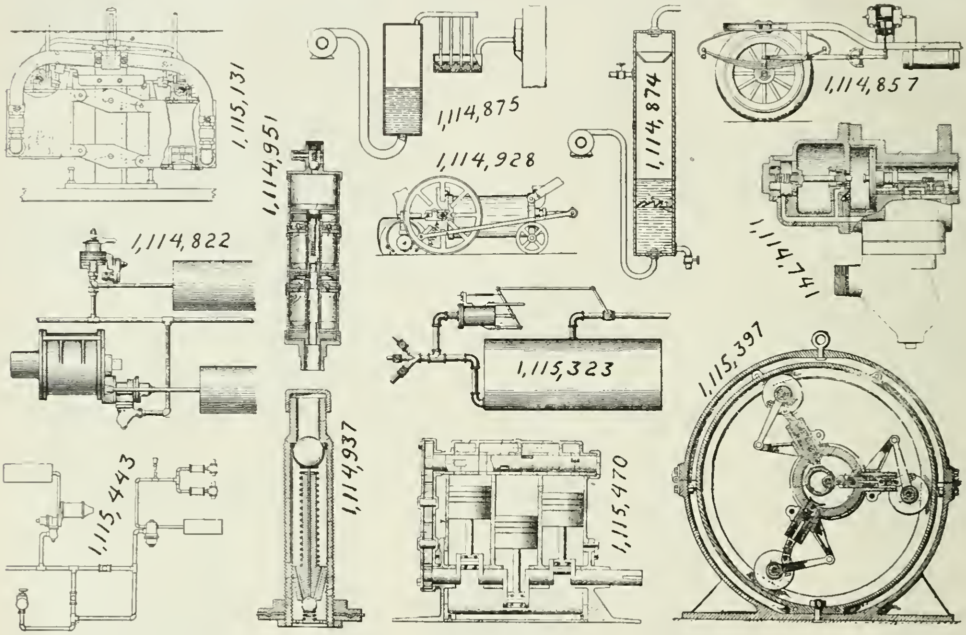
1,114,822. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,114,857. AIR-COMPRESSING SHOCK-ABSORBER. John J. Campodonico, Stockton, Cal.

1,114,874. DEVICE FOR TREATING LIQUIDS. Arthur O. Fox and Russell R. Bates, Madison, Wis.

1,114,875. PROCESS OF TREATING LIQUIDS. Arthur O. Fox and Russell R. Bates, Madison, Wis.

1,114,928. SUCTION-SWEEPER. Frederick Steinkoenig, Cincinnati, Ohio.



Pneumatic Patents October 27.

1,114,937. VALVE FOR PNEUMATIC TIRES. Edward Tessner, Milwaukee, Wis.

1,114,949. ROCK-DRILL. Daniel S. Waugh, Denver, Colo.

1,114,951. POWER FLUID-ACTUATED IMPULSE-PUMP. Carley Gould Weld, North Chatham, Mass.

1,115,131. PNEUMATIC WATER-ELEVATOR. Edwin E. Thomas, Portland, Oreg.

1,115,286. ELECTROPNEUMATIC AIR-BRAKE SYSTEM. John Patrick Costelloe, Medicine Hat, Alberta, Canada.

1,115,323. FLUID-PRESSURE REGULATOR. Lewis S. Mansperger, Troy, Kans.

1,115,367. PRESSURE-REGULATING AIR-CIRCULATING SYSTEM FOR SUBMARINES. Theodorus J. P. Aanstoots, Passaic, N. J.

1,115,397. ROTARY AIR-MOTOR. Leroy Clawson, Hall, Mont.

1,115,435. TIRE-INFLATING PUMP. Willard S. Jobes, San Antonio, Tex.

1,115,443. AUTOMATIC TRAIN-STOP. Frederick I. Leach, Lynn, Mass.

1,115,470. AIR-MOTOR. Carl E. L. Lipman, Beloit, Wis.

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